Phelsuma

Volume 2 **1994**

Contents

Editorial

Changes to *Phelsuma*

In this second issue of *Phelsuma* two changes have been made. A notes section has been added to carry short articles, observations and discussion points. The second change is a less noticeable one: the addition of key words in the longer papers and reports. This move brings us into line with most international journals where key words have little relevance to most readers but facilitate the inclusion of the journal in bibliographic indices. In our case this follows our inclusion in Zoological Record, one of the largest abstracting services publishing annual indices of publications in zoology. Our inclusion means that *Phelsuma* will now be brought to the attention of a far wider audience than we would have achieved otherwise. It is hoped that we will also be covered by Biological Abstracts which is used in all biological and geological fields.

The introduction or colonisation problem

A major preoccupation of island biologists and conservationists is the problem of introduced species of animal or plant. The sudden appearance of large numbers of a given species is often associated with other noticeable changes and the former is almost invariably seen as the cause of the latter. The perceived danger of introductions has led to numerous attempts at controlling the species concerned, rarely with any significant success. This lack of success and the haphazard nature of approaches to control suggest that the whole problem needs considering from an objective viewpoint. Laying aside the tricky question of how control may best be achieved we must first consider what evidence is available for determining whether a species is introduced or not. Given that the economic costs of intervention are high and that control of introductions is extremely costly in terms of good public opinion (and hence fund raising ability) a clear guideline is needed to determine which species should be considered for control. Two factors must be evaluated to achieve this; firstly is the event we wish to control a natural process, and secondly is it causing problems that need solution?

The question of naturalness is a most important one. The fauna and flora of any island has a significant component of dispersive species, ie. species that have colonised after the island was formed. Colonisation is largely a random process and as such is an ongoing one. It is an all too common misconception in biology that biological processes are frozen during the time of observation. The processes that modelled our surroundings continue and are as significant as they ever were, albeit with some modification caused by our own actions. Thus it must be remembered that new species will appear on islands even without human introductions. To control natural new arrivals is to meddle with ongoing processes

in much the same way as controlling the processes of speciation, which no rational conservationist would propose.

If new species are constantly arriving by 'natural' means how can we separate them from those that have been introduced? This question is the obvious next step from the acceptance that some new arrivals are a natural component of the biota, and there is really no clear-cut answer. The only group of new arrivals that we can be entirely sure of are those that were introduced deliberately; these are relatively few in number. Biological control introductions are sometimes well documented, thus we can be sure that in Seychelles the barn owl (*Tyto alba*), the carnivorous snails *Eustreptaxis quadrilateris* and *Euglandina rosea* and a variety of insects are non-native. Incidental documentary evidence or reliable anecdote allows us to be reasonably certain that deliberate introductions were made of species such as the Indian mynah (*Acridotheres tristis*), feral pigeon (*Columba livia*), the giant African snails *Achatina fulica* and *A. immaculata* and the tenrec *Tenrec ecaudatus*. Some species have been observed on arrival, for example we know that the Indian house crows (*Corvus splendens*) arrived by ship and did not fly to the islands on their own. Beyond this it is virtually impossible to be certain of anything.

The last example given above raises what appears at first to be a further problem compounding this whole mess, namely what constitutes un-naturalness in accidental introductions. To examine this aspect we should consider the speculations on the early history of the western Indian Ocean. Suggestions have often been made that before the European discovery of the islands Melanesian voyagers had landed on some of the islands; it is generally accepted that they did colonise northern Madagascar but their presence in the Seychelles area remains debatable. Their presence in Madagascar is supported by cultural similarities and the genetic composition of their presumed descendants but no such ties can be found in Seychelles where there is no doubt that the islands were uninhabited in the 16-1700s. Considering that this same sea-faring race populated every single sizeable island in the Pacific and left behind human populations, domestic mammals and stone carvings it seems inconceivable that they could have reached Seychelles and failed to establish themselves, or to leave any trace other than perhaps a few introduced plant species. If the Melanesian colonist hypothesis were to be accepted in its entirety then at least four plant species would have to be considered as 'introduced', namely *Casuarina equisetifolia*, *Cocos nucifera*, *Hibiscus tiliaceus* and *Morinda citrifolia*. The first three are all highly successful sea or wind dispersers, the fourth is not but is such a revolting smelling fruit it is impossible to imagine how the Melanesians could have crossed the Indian Ocean with it on their rafts (let alone why they would want to carry it!). Given that there are no records from the time it is impossible to substantiate or reject this hypothesis, and a more productive view may be to consider that if plants carried by Melanesians are viewed as introduced through human actions then virtually the entire flora of a vast number of Pacific islands must be treated as alien. This is obviously a nonsensical approach and in the Pacific it is far more appropriate to

consider early human mediated dispersal as a natural process. If this approach is applied to the Indian Ocean we can easily accept our coastal flora as effectively native, whether it drifted, blew or was carried by birds, bats or rafting Melanesians. If rafts nearly 1000 years ago are effectively natural how does modern shipping or aircraft affect the process; should modern stow-aways such us the Indian house crow, the rats *Rattus rattus, R. norvegicus* and the house mouse *Mus musculus* be considered as being naturally occurring?

We can accept rafts of vegetation of any size as a natural means of colonisation and human powered rafts may also be substantially natural. It is hard to find any very convincing difference between these and modern ships other than speed of movement. We have already accepted human powered rafts which are capable of moving faster than drifting ones, and are certainly less current dependent so even the great speed and directionality of ships is not a completely safe dividing line. If we consider this from the standpoint of the biology of the species concerned the problem gets even worse for the species that hide on modern ships are exactly the same ones that would be expected to be found on natural vegetation rafts. For a species to colonise an island by rafting, probability dictates that it should be abundant in the coastal areas where the rafts enter the sea. It must be able to survive for an extended period of time in wet, windy and salty conditions, usually its food supply will be limited so the ability to survive enforced starvation is of benefit. In essence it must be a coastal opportunist, which is exactly the description that would be applied to most of the animals that can be found on ships (from my own experience I can cite ants, flies (*Musca* spp.), cockroaches (*Periplanetta americana*) and geckos (*Hemidactylus* sp.) as abundant species on ships). The important point here is that most of the species that follow us across oceans are also likely to be travelling by the slower route of clinging to drifting rafts, so that even if we were to stop their reaching land with us many would eventually get there on their own. In most cases this would be unlikely to cause any great problems as such species have been colonising since the islands were formed; the 'natural' fauna and flora have been evolving with and adapting to these new arrivals for many millenia. What they are not used to are the non-rafting species. These are the ones we introduce deliberately, species that are not abundant at the coast, that are not generalist feeders, that behave in a manner that is substantially different from most of the established species. The most striking examples are the species we introduce in biological control, and these are the ones that cause the most severe problems. Only one example needs mentioning, that of the carnivorous snail *Euglandina rosea* which has caused the extinction of over 50 species of snail in the Pacific region in the last 20 years. No such drastic disasters have been reported in the Indian Ocean but it should be noted that this is probably simply a result of a lack of research; the potential for disaster is certainly there.

This leaves us with a possible resolution of the problem. If we accept that some introductions may have occurred before the written history of the region started then only the biological properties of the species concerned are of relevance when considering control. Deliberate introductions usually lack the adaptations

that would predispose them to natural colonisation, and as such they represent a substantially un-natural component in the biota. Accidental inroductions may possess those adaptations and thus differ relatively little from the natural component, from which they are indistinguishable. If this approach of accepting accidental introductions as substantially natural were to be used rigorously obvious problems would arise, it would mean accepting such species as Indian house crows, rats and mice as natural colonists. Whilst in many cases good scientific studies are lacking we can be reasonably certain that some of these species have caused notable biological problems through preying on the endemic fauna and flora. It would be best to use the pragmatic approach and state clearly that as we can never be certain that presumed accidental introductions did not occur naturally the majority should be accepted as substantially or effectively natural, with the exception of those species that threaten endemics or species in which we have a particular interest. Thus control measures should only be undertaken for species that have been deliberately introduced or for non-endemic species that threaten ecologically or scientifically important taxa, and then only following from careful study and test projects with precisely defined and evaluated aims. In relation to this the Nature Protection Trust of Seychelles is compiling a full list of taxa recorded in Seychelles and dividing it into those believed to be endemic, indigenous, substantially native or introduced.

Chairman's report

The steady consolidation of the Trust during the past twelve months has inevitably led to an increase in the time spent on Trust related projects. This expansion has brought us to the point where serious consideration needs to be given to the possibility of a permanent NPTS office and facilities for storage of herbaria and specimen collections. Work space in the form of a small laboratory would also be an advantage. We have circulated some tentative proposals and hope to have some response within the next few months.

In January 1994 we wrote to the office of the United Nations Development Programme in response to a circular seeking local consultants for inclusion in their directory of national consulatants. We set out our areas of expertise and interest and described the projects so far completed.

Our representation on the board of the Seychelles Islands Foundation has, we hope, had some influence on the functioning of this body. The SIF has many entrenched perceptions of the way in which it runs Aldabra and it is our main aim to redress this situation of neglect of the scientific obligations that makes continued membership of the SIF worthwhile.

Research projects carried out in the last year included a study of the La Passe marsh on Silhouette. Details of this project are published in this issue. We continued monitoring at the Roche Caiman Bird Sancutary and initiated a long term study of feeding areas for shorebirds. One of our supporters Dr. J. Steinbacher of Senckenberg Museum in Frankfurt arranged a collaborative research project on common noddy terns (*Anous stolidus*) with Dr. Ellen Thaler and Susanne Stabinger from Innsbruck University and the Trust. This work is being carried out on Bird Island and results will be published in future issues of *Phelsuma*.

The Trust found itself involved in two animal rescue operations during the year. The first was the rescue of a caged Seychelles blue pigeon (*Alectroenas pulcherrima*) from an air-conditioned office of the Tourism Department. This bird was sent to Cousin where it was eventually released. The second rescue was that of a crowned lemur (*Lemur coronatus*) that had been held in the quarantine station for some years. On the advice of the Jersey Wildlife Preservation Trust "Loulou" was eventually sent to Mulhouse Zoo in France to join a breeding group on loan from the government of Madagascar.

The Roche Caiman Bird Sanctuary has continued to flourish and with the added facilities of a public hide complete with information board is now fulfilling its role as a centre for education and public awareness. Most visiting special interest groups visit the hide during their stay on Mahé. This public hide was erected last May but the finishing touches were applied in October at the same time as a more traditional wooden hide was erected in the heart of the Sanctuary. Management of the vegetation and islands in the Sanctuary were carried out by members of the Trust.

In April 1994 Gill and I were part of a small group tour to the Galapagos islands off Ecuador where we met Dr Linda Cayot at the Charles Darwin Research Station on Santa Cruz island. We hope to establish ties with CDRS in view of our islands' shared heritage of giant tortoises. There is much that wa can learn about conservation from these wonderful islands.

Many of the activities of the Trust would have been impossible without the greatly appreciated financial support of our sponsors. We would like to thank the following sponsors for help with specific projects:

Mr Donald Fox for funding the information board
EKU (Seybrew) for financing the EKU hide
PUC for financing the public hide
Aluminium and Steel for a discount on the price of the information board
Vijay Construction for building the hides within the budgets
IDC for reduced prices at the guest house for the Silhouette projects

Our major fund raising initiative was a system of sponsor membership offered to corporate bodies. This was made possible through the valued assistance of the British High Commission who financed the printing of the first issue of this journal. The journal, quarterly editions of "Birdwatch" and invitations to all future lectures were offered as an incentive to the sponsor members. We would like to thank the following organisations for accepting:

Seychelles Petroleum Company
Air Seychelles (logistic, not financial support)
Cousine Island Company
Allied Builders
Travel Services Seychelles
Barclays Bank (Independence Avenue)

There were only two lectures held last year. The first was by well known South African bird photographer Peter Steyn. The second lecture was on a snail research project by Justin Gerlach. We hope (especially in view of our offer to sponsor members) to have a fuller calendar of lectures this year.

Finally, our most important sponsor who has put up with invasions of his board room for our lectures, persistent demands for photocopies and faxes and constant nagging of his staff to find time to work on Birdwatch! Many thanks to Edwin Palmer and the staff of Seybrew.

Chairman

1993 Report on Roche Caiman Bird Sanctuary

The main developments at the bird sanctuary were the completion of the public hide on the north fence and the 'Eku' hide inside the sanctuary. These have proved invaluable aids to comfortable bird-watching and bases for management work. The fence was the focus of the main problems during the year with a hole being torn in the wire during the construciton of road drain and a large casuarina trunk ripping the wire during landscaping attempts near the stadium. These holes allowed stray dogs to invade the sanctuary again. Both holes have been patched up and dogs are again excluded; it is to be hoped that the fence will now remain hole-free.

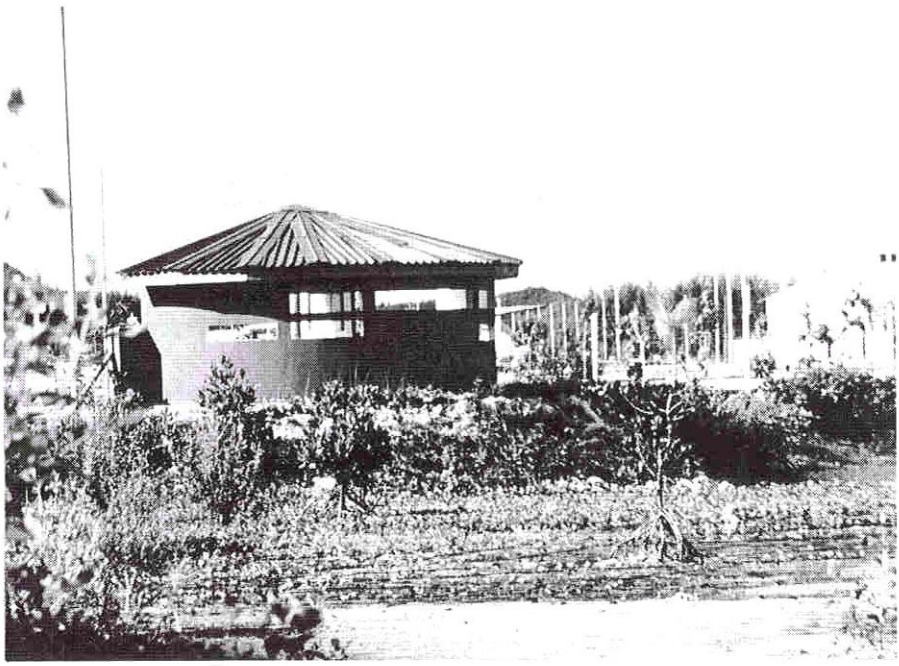


Fig. 1. The hides in the bird sanctuary (Photo: J. Gerlach)

1). Mud sampling

For the first time samples of mud were taken in December 1993. These are discussed in the report on 'Prey abundance and migrant shorebird distribution'.

2). Vegetation surveys

Plants recorded:

Only species recorded or identified for the first time in 1993 are listed below.

	Planted	Colonised <1992	1993
Malvaceae			
Hibiscus tiliaceus	.	+	.
Tiliaceae			
Muntingia calabura	.	+	.
Leguminosae			
Derris trifoliata	+	.	.
Intsia bijuga	+	.	.
Sesbania sericea	.	.	+
Vernonia cinerea	.	+	.
Vigna marina	.	.	+
Combretaceae			
Luminitzera racemosa	+	.	.
Sonneratiaceae			
Sonneratia alba	+	.	.
Solanaceae			
Solanum nigrum	.	.	+
Scrophulariaceae			
Striga asiatica	.	.	+
Acanthaceae			
Asystasia gangetica	.	.	+
Cyperaceae			
Scleria sieberi	.	.	+
Graminae			
Sporobolus diander	.	.	+

Four species recorded previously have so far failed to become established and were not represented at the end of 1993; *Pittosporum senaca, Xylocarpus granatum, Carica papaya* and *Erythrina variegata.*

3). Invertebrates

During 1993 leaf litter samples were taken in July and December. The areas covered by this method remain small, a definitive litter study is planned for 1994.

3a). Mollusca

New mollusc records for the sanctuary are the aquatic/amphibious species *Melampus caffra* and *M. semiauratus*, and the terrestrial carnivores *Gulella bicolor* and *Eustreptaxis quadrilateris*. The last two are introduced species. This brings the number of species recorded to 11.

3b). Crustacea

2 crab species (not identified to date) occur throughout the year. They vary in abundance in different parts of the sanctuary. They are at their most abundant around the edge, reaching 9-10 m^{-2}. In addition to these 22 fiddler crabs (*Uca annulipes*) were introduced to the sanctuary on 12/12/93 in an attempt to increase the diversity of open mud inhabiting animals, increase species likely to break up the surface of the mud and provide food sources for crab eating birds.

3c). Arachnida

A collection of spiders from the bird sanctuary was identified by Dr. M. Saaristo of Turku University, Finland. The following species were recorded:

Ochyroceratidae	1sp - new genus and species
Scytodidae	*Scytodes* sp.
Lycosidae	*Trochosa urbana*
Clubionidae	*Clubiona mahensis*
Corinnidae	*Oedignatha scrobiculata*
Gnaphosidae	*Camillina* sp.
Salticidae	*Heliophantus activus*
Theridiidae	Theridiidae sp.
	Argyrodes rostrata
	Ariames recurvatus
Tetragnathidae	*Nephila inaurata*
Araneidae	*Neoscona morelii*

The new genus of Ochyroceratidae is particularly interesting as it is the commonest species in the bird sanctuary, found at densities of approximately $10m^{-2}$ in the leaf litter.

4). Vertebrates

4a). Fish

The water present at the beginning of the year dried up almost entirely during July. The reduced water volume and its isolation from fresh sources (ie. the sea) resulted in high water temperatures and a corresponding reduction of dissolved oxygen concentration. These conditions killed off all the fish in the pools by 4/7/93, the following species were identified:

Oreochromis mossambicus
Etrumeus teres
Ophiocara porocephala
Kuhlia mugli

Rain and high tides resulted in pools of water reappearing towards the end of the year which, by 2/12/93, had been colonised by *Ophiocara porocephala.*

4b). Amphibians

Tadpoles of the frog *Ptychadena mascariensis* were found in the main pools on 12/12/93. The water in the pools at this stage was mostly rain-water and hence the salinity was low, suitable for tadpole survival. This species is able to tolerate significant salinity levels and often breeds in brackish water.

4c). Reptiles

A new record for the bird sanctuary was a blind snake (*Rhamphotyphlops braminus*) found by Pat Matyot bringing reptile species nubers up to two (the other being the skink *Mabuya sechellensis*).

4d). Birds

Bird records are summarised below:

Species	J	F	M	A	M	J	J	A	S	O	N	D
Pacific golden plover	0	0	0	0	0	0	0	0	0	3	0	3
Grey plover	3	4	7	7	0	1	0	2	17	19	2	6
Ringed plover	0	0	0	0	0	0	0	0	0	0	2	2
Lesser sandplover	0	0	2	12	0	0	0	0	19	15	0	9
Greater sandplover	0	0	5	5	0	0	0	0	0	0	0	0
Bar-tailed godwit	0	0	0	0	0	0	0	0	3	3	0	2
Whimbrel	0	4	11	33	12	18	15	1	45	14	19	44
Eurasian curlew	0	0	0	1	0	0	0	0	1	2	1	2
Marsh sandpiper	0	0	0	0	0	0	0	0	0	0	1	2
Greenshank	8	12	8	25	24	16	27	6	20	11	9	10
Wood sandpiper	0	4	0	1	0	0	0	0	1	0	1	2
Terek sandpiper	0	0	0	1	0	3	0	0	0	2	0	3
Common sandpiper	1	6	1	3	0	0	0	0	1	1	3	4
Ruddy turnstone	0	1	7	4	0	0	0	0	13	15	9	16
Sanderling	0	0	0	0	0	0	0	0	0	0	0	1
Little stint	0	0	0	0	0	0	0	0	1	1	1	2
Curlew sandpiper	0	160	101	12	0	0	0	0	89	140	146	195
Sharp-tailed sandpiper	0	0	0	0	0	0	0	0	1	1	0	0
Grey heron	1	2	1	3	8	7	7	1	3	3	5	6
Green-backed heron	0	5	2	2	6	5	3	0	0	2	0	1
Cattle egret	0	0	4	2	2	0	1	0	2	0	0	3
Little egret	1	1	1	0	0	0	0	0	0	0	0	1
Black-crowned night heron	0	0	1	0	0	0	0	0	0	0	0	0
Garganey	0	0	0	0	0	0	0	0	0	0	0	2
Pintail	0	0	0	0	0	0	0	0	0	0	0	3
Moorhen	0	1	2	1	1	0	0	0	0	0	1	3
White-winged black tern	0	0	2	0	0	0	0	0	0	0	0	0
Common tern	0	0	1	3	0	0	0	0	0	0	0	0
Saunder's tern	0	0	0	1	0	0	0	0	0	0	0	0
Gull-billed tern	0	0	0	0	0	0	0	0	1	0	0	0
Black-headed gull	0	0	0	0	0	0	0	0	0	0	0	1
Snipe sp.	0	1	0	0	0	0	0	0	0	0	0	1
Tree pipit	0	0	0	0	0	0	0	0	0	0	0	2

Prey abundance and migrant shore bird distribution

J. Gerlach & R. Gerlach
PO. Box 207, Victoria, Mahé, SEYCHELLES

Key words: Seychelles, shorebirds

Abstract

A brief study of shorebird numbers, feeding patterns and prey abundance on Mahé, Seychelles indicated that the patterns of utilisation by shorebirds can be explained in terms of the abundance of prey and the nature of the substrate. This study demonstrated that invertebrates are relatively scarce in the mud of the Roche Caiman Bird Sanctuary, possibly due to this area regularly switching between being a brackish and a freshwater environment.

Introduction

The invertebrate faunas and substrate types of the different areas exploited by migrant waders on the east coast of Mahé, Seychelles, were compared in December 1993 in an attempt to explain the observed distribution of waders and to identify means of further enhancing the importance of the Roche Caiman Bird Sanctuary. It seems likely that the abundance of food organisms is the major factor determining the use of the areas at low tide (the bird sanctuary clearly being an important high tide roost, but not being used for feeding by many species).

Methods

Five areas on the east coast of Mahé, Seychelles, were investigated:

1). Cascade mudflats
2). mudflats near the Seybrew factory
3). Roche Caiman Bird Sanctuary
4). channel near the Harbour View guest house
5). Inter-Island Quay

The first of these sites was formed as a result of dredging operations in 1986, it is used as a high tide roost and a feeding ground for curlew sandpipers (*Calidris ferruginea*). Cascade and Seybrew mudflats have long been major feeding grounds for curlew sandpipers. Both were covered in fine coral silt after the 1986 and 1990 dredging of the East Coast Project. This project also caused some siltation of the Inter-Island Quay which is heavily utilised by all wader species. The Harbour View channel is a river mouth and was relatively undisturbed by siltation. It is not used by many waders.

Two methods were used in determining the densities of animal populations in the marsh. Sieving 0.05m^2 of mud through 1mm mesh was used to record numbers of macro-invertebrates, these were identified to class at least, to date only a few have been identified to species. These were supplemented by visual estimates of numbers in square metre quadrats (principally for crabs which could be identifed by sight and often took evasive action during sieving, resulting in under-representation). All samples were taken on 10/12/93 with the exception of sample 3c which was carried out on 28/12/93, 21 days after rain had created a fresh water habitat in the bird sanctuary. This sample was a repeat of sample 3b and was made after sufficient time had elapsed for a fresh-water community to begin developing in the bird sanctuary.

The volume of silt remaining in the sieve was recorded (in cm^3 per 0.05m^2) to allow a comparison of the approximate particle size of the mud, a factor that is likely to influence the prey catching ability of some bird species.

Results

The results are presented in Table 1. in numbers of individuals per m^2, the numbers of birds seen feeding at each site are shown in Table 2.

Table 1.

	Animals per m^2	1.	2.	3a. (mud)	3b.(fresh water)	3c.(fresh water)	4.	5.
Mollusca	*Terebralia*	20	0	0	0	0	0	0
	Hydrobidae	0	0	0	0	0	20	0
	Assimineidae	0	0	0	0	0	0	40
Annelida	Polychaeta	540	40	0	0	0	680	0
Crustacea	*Uca* spp. 1.	0	180	0	0	0	220	240
	Malacostraca	0	0	0	0	0	20	0
	Isopoda	0	0	0	0	0	0	60
	Amphipoda	0	0	0	0	0	0	0
	Tanaidacea	3380	60	0	0	0	660	10280
Insecta	Diptera	0	0	0	0	420	20	0
	Coleoptera	0	0	0	0	20	0	0
	Odonata	0	0	0	40	0	0	0
Total		3920	280	0	40	440	1620	10620
silt (cm^3)		130	125	190	120	125	125	250

Discussion

Several features of this comparison are notable: the bird sanctuary mud is very species poor in comparison to all other sites, polychaete worms are only abundant in the Cascade mud flats and the Inter-Island Quay (some also present at Seybrew), Tanaidacean shrimps are abundant at Cascade and Harbour View and a change in the fresh-water community of the bird sanctuary was apparent within 3 weeks.

Table 2.

Species	Numbers feeding per hectare				
	1.	2.	3.	4.	5.
Crab plover					2.8
Grey plover		0.5	0.3		0.3
Ringed plover			0.7		
Lesser sandplover					1.0
Bar-tailed godwit		0.2			
Whimbrel	0.2	0.5		0.2	0.7
Marsh sandpiper			0.7		
Greenshank		0.2	0.7		
Terek sandpiper					0.7
Common sandpiper			0.7		
Ruddy turnstone		0.5	2.8	1.7	2.8
Little stint			0.7		
Curlew sandpiper		0.7	27.6	1.7	24.8
Northern oystercatcher		0.2			0.3

In the above table the numbers of birds feeding at Cascade is anomalous; most visits to this site showed that this is the main feeding area for curlew sandpipers, however during the counts used in this study no curlew sandpipers were seen at this site. The reason for this is not known, it indicates the need for further records in this study.

The pattern of utilisation by the birds is clearly correlated to the macro-faunal prey composition. Curlew sandpipers feed mainly in sites where Tanaidacea and polychaetes are abundant; they are also able to exploit the microscopic fauna that is presumably present in bird sanctuary, but was not sampled. The abundance of crabs at the Inter-Island Quay accounts for crab-plovers feeding exclusively at this site, lower numbers of crabs at Harbour View attract grey plovers and turnstones to this and the preceding site. Turnstones were observed eating crabs at these sites and were the only species observed to hunt the more wary crabs in the bird sanctuary. Crabs are present in the bird sanctuary in large numbers, but tend to concentrate around the edges of the mud in the shelter of rock piles and vegetation. The fiddler-crabs are most important as a shorebird food resource as they occur on the exposed mud and are thus relatively easy to catch. An oystercatcher was observed feeding on a hermit crab (*Coenobita* sp.) at Site 2.. The numbers of the smaller crustacea and worms probably influence the behaviour of greenshank and whimbrels.

In all these comparisons the Harbour View site would appear to be suitable for most species in terms of its prey composition - it supports prey species that should attract curlew sandpiper, turnstone and crab plover. The number of birds is much lower than expected, probably as a result of the relatively high silt volume. This measure indicates that particle size is relatively large (as would be expected where a stream flows through the mud, washing out the smaller particles) and hence less easily penetrated by the beaks of the smaller birds; the efficiency of curlew sanpipers has been reported to decrease when foraging in areas of large sand particles (Kalejta & Hockey 1994). The larger particles also result in the

interstitial spaces between particles being relatively large, providing hiding spaces for some taxa that are normally surface, or sub-surface, dwellers. In accordance with this fiddler crabs are abundant but mostly as small individuals within the mud itself - thus not easily available to surface feeding crab plovers.

The bird sanctuary lacks both significant mud macro-fauna and a fresh-water fauna. The former is probably due to the periodic filling with fresh-water from rain and to the long, narrow channel that connects it with the sea. This has two right angled bends in it which may inhibit colonisation from the sea by polychaetes and some crustacea. The poor fresh-water fauna is probably due to the marine influence and seasonal desiccation. Within three weeks at the end of December the fauna had developed considerably, large numbers of diptera were present (principally as mosquito larvae in the water, but also as small flies on the surface of the algal mats) and a species of aquatic beetle had also colonised. Dragonfly and damselfly larvae are present for a large proportion of the time and the adults can usually be observed hawking over the deep pools. Most of these insects are probably preyed on more by fish than by birds although curlew sandpipers may take mosquito larvae.

These samples indicate that the abundance of macro-invertebrates is much lower than in many other shorebird over-wintering sites. South African estuaries used by a similar range of shorebird species support over twice as many invertebrates (24073-104577 m^{-2}) although the composition is similar (2-36% polychaetes in the Berg estuary, South Africa (Kalejta & Hockey 1994), compared to 0-42% on Mahé). The diet of the shorebirds on Mahé is not known at present; in South Africa polychaetes are the predominant food source for curlew sandpipers (40-72%) and grey plovers (49-85%) (Kalejta & Hockey 1994), but it is possible that the relative scarcity of invertebrate prey may lead to a less specialised diet with greater numbers of the abundant Tanaidacean crustacea being consumed.

References

Kalejta, B. & Hockey P.A.R. 1994
Distribution of shorebirds at the Berg estuary, South Africa, in relation to foraging mode, food supply and environmental factors. *Ibis* **136**; 233-239

The Management and Conservation of the La Passe Marsh, Silhouette

J. Gerlach,
PO. Box 207, Victoria, Mahé, Seychelles

Key words: Seychelles, marsh, ecology

Abstract

An investigation into the ecology and state of preservation of the La Passe marsh system on Silhouette resulted in the following proposals:

1). Water consumption must be carefully managed to maintain water levels in the main marsh.
2). The ruined old bridge between the school and the farm should be restored as beach erosion will soon lead to the sea cutting the present track to the farm.
3). The area of mud by the farm should remain as it is at present. Removal of rubbish from this area is required, consideration should be given to fencing it off from the path by the school.
4). The bed of the channel by the IDC guest house should be heightened by 30-50cm to ensure its complete drainage, preventing stagnation.
5). The shallow marsh by the Dauban tomb should be deepened to restore it to a functional freshwater marsh.

In addition to these specifically marsh related proposals the preservation of the forests is essential for water resource conservation. Management of water resources would be further facilitated by reafforestation of the exposed areas around La Passe.

Project aims

The La Passe marsh system on Silhouette was studied by the Nature Protection Trust of Seychelles to provide recommendations to the island's management (Islands Development Company) for the rehabilitation of the coastal marsh. Research was carried out in two stages; the first carried out by J. Gerlach and L. Canning between 27th July - 4th August 1993, and the second by J. Gerlach between 14th - 21st December 1993, covering both seasons of low water availability and maximum rainfall.

Research involved mapping, habitat characterisation, animal surveys, water flow measurement and identification of possible threats to the long-term viability of the marsh.

Marsh areas

With low water levels as experienced during the south-east trade winds four distinct marshy areas can be identified. These are listed below with their approximate areas (based on measurements from aerial photographs, maps and on site estimates):

1). Dauban tomb marsh (190m^2) - partially drained
Channel by the IDC guest house (20m^2) - scrub and stagnant water
3). Main marsh (535m^2) - a large area of deep water, shallow pools and mud, fringed with mangroves, trees and reeds. This is the only area that receives water throughout the year due to its connection with the Grande Riviere. This can be subdivided into three sections:
3A). Main marsh (350m^2)
3B). Farm marsh (170m^2) - shallow water and mud between the school and the farm
3C). Reed pool (15m^2) - a pool of *Typha javanica* reeds at the back of the marsh
4). Marsh channel behind the animal farm (50m^2) - a muddy channel with small areas of standing water.

Habitats

Several habitats are clearly defined within the marsh:

1). Mangroves - predominantly *Rhizophora mucronata, Acrostichium aureum* and *Derris trifoliata.*
2). Reeds - small beds of *Typha javanica* at the end of streams.
3). Open mud - vegetation cover less than 5%, the remainder being exposed mud.
4). Open water - no overhanging vegetation.

and in the surrounding areas:

5). Suburban - human settlement.
6). Agricultural - intensive animal rearing (large permanent buildings), arable (open habitat with no significant tree cover - pineapples, manioc and guava).
7). Forest - near the marsh this habitat is represented by a narrow line of trees in some stream beds and an extensive area along and to the north of the Grande Riviere.

Animal life

Molluscs are especially abundant in the marsh, these include a small mussel species, the freshwater snails *Melanoides tuberculata* and *Neritilia consimilis*, and the mangrove snail *Terebralia palustris*. Crab species observed were *Uca annulipes*, *Sesarma impressum* and *Cardisoma carnifex*. Barnacles of one species are abundant.

Mangrove marshes are known to act as major fish nurseries, making their protection important in maintaining inshore fisheries. During this investigation it proved impractical to identify all the fish species using the La Passe marsh. The species identified were tilapia (*Oreochromis mossambicus*), mudskippers (*Periopthalmus sobrinus*), the goby *Ophiocara porocephala*, mullet (Muglidae

spp.), barracuda (*Sphyraena* sp.), snappers (*Lutjianus gibbus* and *L. flaviflamma*) and sap-sap (*Monodactylus argentea*).

Two methods were used in determining the densities of animal populations in the marsh. Sieving $0.05m^2$ of mud through 1mm mesh was used to record invertebrate numbers, and this was supplemented by visual estimates of the numbers of crabs in square metre quadrats. Fish were recorded in 5m wide transects along bridges and paths, each of these was repeated 10 times. The numbers of each species recorded in December 1993 are shown in Table 1. as numbers per square metre (taxa that were observed but did not appear in samples or transects are recorded by a +).

Table 1.

		1.	2.	3A.	3A. (back)	3B. (water)	3B. (mud)	4.
Molluscs	bivalves	0	0	60	670	0	0	0
	Syncera nitida	0	0	0	10	0	0	0
	Terebralia	0	0	1160	760	400	0	0
	Melanoides	30	0	+	0	200	240	560
	Neritilia	0	0	+	0	0	0	0
Echinoderms	Ophiuroidea	0	0	+	0	0	0	0
	Holothuria	0	0	+	0	0	0	0
Crustaceans	Malacostraca	0	0	+	0	0	0	0
	Sesarma	+	0	0	+	+	+	0
	Cardisoma	+	0	0	0	0	+	0
	Uca annulipes	+	0	0	0	0	0	0
	Amphipoda	10	0	0	0	0	0	0
	Isopoda	+	0	+	530	0	0	0
Insects	Diptera	90	0	0	0	0	0	600
Fish	Muglidae spp.	0	0	0.011	0.003	0	0	0
	Lutjianus gibbus	0	0	0.071	0.003	0	0	0
	L. fulviflamma	0	0	0.017	0	0	0	0
	Sphyraena sp.	0	0	+	+	0	0	0
	Monodactylus	0	0	+	0.037	0	0	0
	Ophicara	0	0	0.014	+	0	0	0
	Periopthalmus	+	+	+	+	+	+	
	Oreochromis	0	+	0.149	0.033	0	0	0
	fry	0	0	9.429	0.333	300	0	0
Amphibians	*Ptychadena*	0	+	0	0	0	0	300

Fish numbers can be calculated from the densities above and the estimated areas. These were recorded both in July/August and December 1993, and are compared in Table 2. Heavy rainfall early in December resulted in the main marsh overflowing into the sea on the 12th December. The opened channel continued draining until 18th December when the water fell to a level that allowed tidal movement of sand to close off the channel again. During the time the channel was open fish moved in both directions between the sea and the marsh. This event is the main reason for the pronounced changes in fish numbers. With

the rapid outflow of water during 12-13th the larger fish moved from the marsh to the reef and

Table 2.

	July/August	December	change
Muglidae spp.	25	4	-21
Lutjianus gibbus	9	35	+26
L. fulviflamma	0	8	+8
Sphyraena sp.	2	+	-2
Monodactylus	56	13	-43
Ophicara	12	5	-7
Periopthalmus	5	+	-5
Oreochromis	45	52	+7
fry	15	3300	+3285

open sea (the mullet, barracuda and sap-sap). Of the other species the adult snappers in the marsh also moved into the sea. The numbers of snappers in the table above do not show any corresponding decline, this is due to juvenile snappers moving into the marsh from the sea. This immigration of small fish into the marsh also accounts for the extremely high increase in the numbers of unidentified fish fry. Fish were observed entering the marsh on 14-16th at the rate of 4 per minute. This movement presumably started on the 12th, giving 5 days of fish immigration and a total of 28800 juvenile fish.

Given that the majority of the marine fish entered the sea in December and were replaced by juveniles of the same species it can be seen that in 1993 the marsh provided a nursery for approximately 30 mullet (Muglidae spp.), 50 snappers (*Lutjianus gibbus* and *L. flaviflamma*), 2 barracuda (*Sphyraena* sp.) and 70 sap-sap (*Monodactylus argentea*); over 150 commercially important fish. This number is very low in comparison to the estimated 3300-28800 fry entering the marsh. The mortality rate of the fry in the marsh is expected to be high but the difference may be related to the water levels in the marsh (discussed below) and may indicate that in 1993 the La Passe marsh ecosystem did not function at its most productive potential.

Flow rates

The data on these are summarised below:

	Rate (m^3 per second)	
Locality	July	December
Grande Riviere - at pipes feeding storage tanks	0.0315	0.0780
Water entering marsh	0.0005	0.0410
Water extracted for human consumption	0.0144	0.0200
Water extracted for the animal farm	0.0168	0.0170
Loss from main marsh	0.0005	0.0491
Loss from guest house marsh	0	5.21×10^{-6}

A comparison of the rates of water flow at different parts of the Grande Riviere show that in July/August 1993 virtually all the water was being extracted for

human or agricultural use (0.0312 m^3 per second or 99%), as a result the water flowing into the marsh was less than that being lost through drainage and evaporation. At least 0.0005 m^3 per second were required to balance this loss and prevent water levels in the marsh falling. In December 1993 the increased rainfall resulted in a greater volume of water, extraction for human use and agriculture totalling only 41% of the water. As the marsh had broken its banks drainage exceeded water entering the marsh.

These data demonstrate that the marsh requires at least 0.0005 m^3 per second of water at all times. In dry periods the almost complete extraction of water for La Passe is a problem. In order to ensure that the marsh functions properly a maximum of 0.03 m^3 per second can be extracted. This is slightly less than was being extracted in 1993, it should be noted that 1993 was not an exceptionally dry year and flow rates in the Grande Riviere could fall even more. Thus 0.03 m^3 per second should be regarded as an absolute maximum.

Threats to the long-term viability of the marsh

Parts of the La Passe marsh system have been destroyed by drainage operations during the island's history. At present no additional drainage is being undertaken. Siltation is not apparent in the marsh, avoidance of this threat requires the continued preservation of the mountain forest areas.

Whilst pollution appears to be the primary problem facing most of the marshes in Seychelles this does not seem to be the case on Silhouette. No evidence of any large scale refuse dumping was observed in the main marsh system although litter is present. The exception to this is the channel behind the farm where the waste from the chicken farm is dumped as is at least some of the waste from the pig farm. Avoiding the development of a litter problem is important due to the threat to fish life posed by the commonest forms of litter. In August a fish trapped in a polythene bag was observed in the marsh near the farm. Being trapped inside this particularly common form of litter leads to suffocation for aquatic life, the fish was subsequently observed to have died whilst trapped. It is important that litter in the marsh does not increase so that un-natural fish deaths remain insignificant. Any increase in littering will result in an increase in fish mortality and a decrease in the value of La Passe as a fish nursery.

The general increase in disposable packaging does lead to increased dropping of litter. At present the practice of sweeping the open areas of La Passe does remove the litter on the ground and maintains the generally clean appearance of the island. This does not remove plastic bags and sweet wrappers that have blown into the marsh before being swept up. The increase in this form of pollution warrants the provision of litter bins around La Passe to reduce the litter on the ground that may be blown into the marsh.

The main threat to the La Passe marsh is water extraction as discussed above. The volume of water entering the marsh is insufficient to balance the volume lost through evaporation. A reduction in the water level during the middle

of the year is part of the natural cycle, however the present low levels prevent contact with the sea, reducing the value of the marsh as a fish nursery.

Recommendations

Recommendations for the marsh system as a whole are:

1. Control water extraction by avoiding wasteful use, increased storage and restricting population increase
2. Avoid pollution by ensuring that organic pollution from settlement or farm does not occur and by reducing littering.
3. Maintain and improve the integrity of the watershed of the Grande Riviere through forest management and reafforestation of the exposed area above La Passe. This exposed area is currently occupied by guava (*Psidium guajava*), pineapple (*Ananas comosus*) and manioc (*Manihot esculenta*) plantations; it is very hot and subject to desiccating winds. The desiccation of the soil caused by the exposure has not been quantified but can be presumed to be a significant source of water loss from the underground reservoirs of the Grande Riviere. This water loss would be significantly reduced if the area were reafforested with native coastal trees providing shade for the ground and acting as a wind-break.

In addition to these general recommendations specific measures were proposed for each of the defined marsh areas.

Seychelles Bird Records Committee - a progress report

A. Skerrett,
PO Box 336, Victoria, Mahé, SEYCHELLES

The Seychelles Bird Records Committee was formed in 1992. Accepted records to date have been published in the journal "Birdwatch". Work on the backlog of records is continuing and this will undoubtedly lead to more species being added to the Seychelles list. However, the time is opportune to publish a first summary of the accepted records to date. These are as follows:

Southern Giant Petrel (*Macronectes giganteus*)
1 record Mahé; 1 individual)
Pintado Petrel (*Daption capense*)
1 record between Cosmoledo and Assumption (1 individual)
Jouanin's Petrel (*Bulweria fallax*)
2 records: 1 near Aldabra, 1 near Desnoeufs (2 individuals)
Wilson's Storm Petrel (*Oceanites oceanicus*)
2 records: 1 near Bird, 1 between Farquhar and Desnoeufs (7 individuals)
Red-billed Tropicbird (*Phaethon aethereus*)
1 record: Bird (1 individual)
Great Cormorant (*Phalacrocorax carbo*)
1 record: Cousin (1 individual)
European Bittern (*Botaurus stellaris*)
1 record: Aride (1 individual)
Black-crowned Night Heron (*Nycticorax nycticorax*)
1 record: Mahé (1 individual)
Indian Pond Heron (*Ardeola grayii*)
1 record: Mahé (1 individual)
Great White Egret (*Egretta alba*)
2 records: 1 Mahé, 1 Praslin (2 individuals)
Purple Heron (*Ardea purpurea*)
6 records: 3 Bird, 1 La Digue, 1 Aride, 1 Mahé (6 individuals)
White Stork (*Ciconia ciconia*)
2 records: 1 Mahé, 1 Bird (4 individuals)
Sacred Ibis (*Threskiornis a. aethiopicus*)
1 record Aldabra (1 individual). Note this individual was of the nominate race, not the race *abbotti* resident on Aldabra
Greater Flamingo (*Phoenicopterus ruber*)
2 records: 1 Mahé, 1 Farquhar (2 individuals). Note this excludes Aldabra where the species is annual.
White-faced Whistling Duck (*Dendrocygna viduata*)
3 records: Aldabra (3 individuals)

Ruddy Shelduck (*Tadorna ferruginea*)
1 record: Mahé (1 individual)
Nortern Pintail (*Anas acuta*)
2 records: 1 Mahé, 1 Cousin (6 individuals)
Northern Shoveller (*Anas clypeata*)
1 record: Assumption (1 individual)
Black Kite (*Milvus migrans*)
4 records: Aldabra (4 individuals)
Northern Marsh Harrier (*Circus aeruginosus*)
1 record: Fregate (1 individual)
Booted Eagle (*Hieraaetus pennatus*)
1 record: Mahé (l individual)
Western Red-footed Falcon (*Falco vespertinus*)
1 record: Bird (l individual)
Peregrine Falcon (*Falco peregrinus*)
3 records: 2 Aldabra, 1 Cousin (3 individuals)
Corncrake (*Crex crex*)
1 record: Bird (1 individual)
White-breasted Waterhen (*Amauronis phoenicurus*)
1 record: Mahé (l individual)
Northern oystercatcher (*Haemantopus ostralegus*)
2 records: 1 Aldabra,1 Mahé (2 individuals)
Common Pratincole (*Glareola pratincola*)
3 records: 2 Praslin, 1 Fregate (3 individuals)
Oriental Pratincole (*Glareola maldivarum*)
2 records: 1 Praslin, 1 Mahé (3 individuals)
Black-winged Pratincole (*Glareola nordmanni*)
3 records: 1 Fregate, 1 Mahé, 1 Alphonse
Little Ringed Plover (*Charadrius dubius*)
4 records: 1 Cousin, 1 Fregate, 2 Mahé (4 individuals)
Caspian Plover (*Charadrius asiaticus*)
5 records: 2 Bird, 1 Fregate, 2 Praslin (7 individuals)
Pintail Snipe (*Gallinago stenura*)
1 record: Aldabra (1 individual)
Great Snipe (*Gallinago media*)
1 record: Praslin (1 individual)
Common Snipe (*Gallinago gallinago*)
2 records: 1 Fregate, 1 Mahé (2 individuals)
Black-tailed Godwit (*Limosa limosa*)
2 records: 1 Bird, 1 Alphonse (2 individuals)
Little Whimbrel (*Numenius minutus*)
1 record: Bird (1 individual)
Common Redshank (*Tringa totanus*)
1 record: Mahé (1 individual)

Marsh Sandpiper (*Tringa stagnatilis*)
1 record: Mahé (3 individuals)
Great Knot (*Calidris tenuirostirs*)
1 record: Mahé (1 individual)
Temminck's Stint (*Callidris temminckii*)
3 records: 1 Bird, 2 Mahé (4 individuals)
Long-toed Stint (*Callidris subminuta*)
1 record: Mahé (l individals)
Pectoral sandpiper (*Calidris melanotos*)
1 record: Bird (l individual)
Ruff (*Philomachus pugnax*)
9 records: 3 Mahé, 2 Cousin, 2 Bird, 1 Fregate, 1 Praslin (9 individuals)
Red-necked Phalarope (*Phalaropus lobatus*)
2 records: 1 Denis, 1Mahé (2 individuals)
Black-headed Gull (*Larus ridibundus*)
10 records: 5 Mahé, 4 Praslin, 1 between Praslin and Cousin (16 individals)
SandwichTern (*Sterna sandvicensis*)
2 records: 1 Mahé, 1Cousin (2 individuals)
Black-naped Tern (*Sterna sumatrana*)
1 record: Bird (1 individual). Note this species breeds in the southern coralline islands and records are collected for east of Amirantes only.
Whiskered Tern (*Chlidonias hybridus*)
2 records: Mahé (2 individuals)
Great Spotted Cuckoo (*Clamator glandarius*)
1 record: Bird (1 individual)
Pied Cuckoo (*Clamator jacobinus*)
1 record: Bird (1 individual)
Common Cuckoo (*Cuculus canorus*)
6 records: 5 Mahé, 1 Aride (6 individuals)
Asian Lesser Cuckoo (*Cuculus poliocephalus*)
1 record: Fregate (l individual)
Common Swift (*Apus apus*)
8 records: 2 Aldabra, 5 Bird, 1 Fregate (10 individuals)
Little Swift (*Apus affinis*)
1 record: Mahé (1 individual)
Needle-tailed Swift (*Hirundapus caudacutus*)
1 record: Mahé (2 individuals)
Blue-cheeked Bee-eater (*Merops persicus*)
4 records: 1 Aldabra, 1 Bird, 1 Mahé, 1 Cousin (9 individuals)
Northern Roller (*Coracias garrulus*)
13 records: 4 Aldabra, 2 Aride, 2 Mahé, 1 African Banks, 3 Praslin, 1 Bird (14 individuals)
Broad-billed Roller (*Eurystomus glaucurus*)

23 records: 17 Aldabra, 3 Cosmoledo, 1 Providence, 2 Bird (24 individuals)

Mascarene Martin (*Phedina borbonica*)

4 records: 2 Aldabra, 1 Desneoufs, 1 Bird (4 individuals)

Sand Martin (*Riparia riparia*)

7 records: 2 Aldabra, 2 Mahé, 3 Fregate (9 individuals)

Barn Swallow (*Hirundo rustica*)

31 records: 17 Aldabra, 5 Fregate, 3 Mahé, 3 Aride, 1 Bird, 1 Praslin, 1 between Praslin and Cousin (55 individuals)

House Martin (*Delichon urbica*)

3 records: 2 Aldabra, 1 Farquhar (4 individuals)

Yellow Wagtail (*Motacilla flava*)

9 records: 4 Aldabra, 3 Mahé, 2 Bird (10 individuals)

Grey Wagtail (*Motacilla cinerea*)

3 records: 1 Bird, 1 Marie Louise, 1 Fregate (5 individuals)

White Wagtail (*Motacilla alba*)

4 records: 2 Mahé, 1 Aldabra, 1 Bird (5 individuals)

Tree Pipit (*Anthus trivialis*)

27 records: 11 Aldabra, 3 Bird, 2 Mahé, 1 Etoile, 1 African Banks, 5 Fregate, 1 Cousin, 2 Aride, 1 Alphonse (45 individuals)

Red-throated Pipit (*Anthus cervinus*)

7 records: 1 Mahé, 2 Fregate, 1 Bird, 2 Praslin, 1 Alphonse (14 individuals)

Rock Thrush (*Monticola saxatilis*)

2 records: 1 Farquhar, 1 Fregate (2 individuals)

Redstart (*Phoenicurus phoenicurus*)

3 records: 2 Aride, 1 Cousin (3 individuals)

Whinchat (*Saxicola rubetra*)

1 record: Bird (1 individual)

European Wheatear (*Oenanthe oenanthe*)

27 records: 21 Aldabra, 4 Bird, 1 Mahé, 1 Fregate (30 individuals)

Isabelline Wheatear (*Oenanthe isabellina*)

1 record: Praslin (1 individual)

Sedge Warbler (*Acrocephalus schoenobaenus*)

1 record: Cousin (1 individual)

Willow Warbler (*Phylloscopus trochilus*)

1 record: Fregate (1 individual)

Wood Warbler (*Phylloscopus sibilartix*)

1 record: Cousin (1 individual)

Icterine Warbler (*Hippolais icterina*)

1 record: Aride (1 individual)

Blackcap (*Sylvia atricapilla*)

1 record: Curieuse (1 individual)

Whitethroat (*Sylvia communis*)

1 record: Aldabra (1 individual)

Spotted Flycatcher (*Muscicapa striata*)

16 records: 13 Aldabra, 1 Bird, 1 Cousin, 1 Aride (18 individuals)

European Golden Oriole (*Oriolus oriolus*)

4 records: 2 Aldabra, 1 Bird, 1 Aride (4 individuals)

Red-backed Shrike (*Lanius collurio*)

2 records: 1 Cosmoledo, 1 Aldabra (2 individuals)

Lesser Grey Shrike (*Lanius minor*)

1 record: Aldabra (1 individual)

Woodchat Shrike (*Lanius senator*)

1 record: Aride (1 individual)

Rose-coloured Starling (*Sturnus roseus*)

1 record: Fregate (1 individual)

Ortolan Bunting (*Emberiza hortulana*)

1 record: Aride (1 individual)

In addition to the above list of 85 species, the Seychelles Bird Records Committee have accepted an additional 85 species of annual occurrence for which no records are required to be submitted unless thay are for species which are vagrants to a particular area of Seychelles. Therefore at the present time the number of accepted species is 170.

Summary of publications in 1993

Floater, G.J.

Lepidoptera on endemic plants of the Seychelles. *Entomologist's Record* **105**: 255-256.

The larvae of six moths are described with records of food plants. The species *Hippotion eson, Chrysodeixis chalcites, Bocana* sp., *Platyptilia* sp. nr. *citropleura, Herpetogramma licarsisalis* and *Epermenia* sp. are reported from the *Pisonia sechellarum* forest on Silhouette.

Jâch, MA

Microlara gen.n. *mahensis* sp.n., from the Seychelles (Coleoptera: Elmidae, Larainae). *Zeitschrift de Arbeitgemeinshaft Osterrichischer Entomologen* **45(1/2)**: 15-18.

Describes the first recorded riffle beetle from Seychelles.

Komdeur, J.

Fitness-related dispersal. *Nature* **366**; 23-24

Research on nest-helping in the Seychelles brush warbler (*Acrocephalus sechellensis*) is discussed in relation to the genetic relationships of the birds and the advantages or disadvantages of dispresal or nest-helping.

Linfield, M.C.J., Raubenheimer, D., Habler, C. & Speight, M.R.

Leaf miners on *Ochna cilata* (Ochnaceae) growing on Aldabra atoll: patterns of herbivory in relation to goat browsing and exposure to the sun. *Ecol. Entomol.***18**: 332-338.

The relationship between leaf miners and gats is examined concluding that stresses caused by exposure to sun predispose plants to both miner and goat herbivory. No conclusion was reached as to whether leaf miner infestation made plants more vulnerable to goat browsing.

Malicky, H

Three new caddisflies from Mahe island, Seychelles. *Braueria* **20**: 19-21.

Describes *Oxyethira sechellensis, Ecnomus maheensis* and *Seselpsyche matyoti,* bringing the total number of caddisfly species on Mahé to 10. *Ecnomus insularis* is figured.

Animal rescues

When Jurong Bird Park in Singapore requested some Seychelles blue pigeons (*Alectroenas pulcherrima*) to add to their collection of exotic birds, the request was dealt with by the tourism department. The birds were caught in mist nets at La Misere from a flock known to frequent the area. Among the birds caught were two dependant juveniles which could not be released into the wild in case the parent birds were amongst those sent to Singapore.

These juveniles were hand reared and were eventually moved to the offices of the tourism department where they were kept in parrot cages. A third blue pigeon which was found with a broken wing was also brought into the same office. This bird had its wing set and pinioned by the veterinary department.

The cramped cages and the failure of the Conservation Department to have the birds removed to more spacious surroundings left many people feeling frustrated. When we proposed to exchange the birds for a painting of blue pigeons in return for releasing the birds into a safe environment on Cousin, our proposal was accepted. Unfortunately, due to a logistic problem it was not possible to move the birds for a further four weeks. By the time arrangements had been made, the two young birds had been sent as a gift to a dignitary in the Gulf.

The pinioned bird was taken to Cousin where it was placed in a more spacious makeshift cage. At first there was some concern about how drastic by the pinioned wing had been cut, but when the bird moulted its primaries regrew and it was released at a time when a flock of blue pigeons were feeding in the trees on Cousin. The brunt of the feeding problems fell on the shoulders of John Souyana who soon had the pigeon in peak condition. It had arrived on the island looking very lack lustre and the facial wattles were very anaemic - yellow instead of bright red.

Towards the end of 1993 a tortoise was found on Mahé and reported as the endangered Madagascan flat-tailed tortoise (*Pyxis planicauda*), the Jersey Wildlife Preservation Trust was contacted in an attempt to incorporate this animal into their captive breeding programme for the species. During negociations the tortoise was examined and found to have been mis-identified; it was in fact a Bell's hinged tortoise (*Knyxis bellina*), an abundant species from east Africa and Madagascar. At the same time we were asked by the acting director if we could help with the repatriation of a lemur that was being kept in the quarantine kennels at Union Vale. We identified the lemur as a female crowned lemur (*Lemur coronatus*) (an endangered species found in a restricted area of northern Madagascar where it is threatened by habitat destruction) and asked the Jersey Wildlife Preservation Trust if they could assist with its rescue. Dr Brian Carroll immediately contacted the European Prosimian Coordinators who decided that the best plan for the lemur would be with a breeding group held by the Parc Zoologique et Botanique de Mulhouse in France due to its obvious tameness which

would make survival in the wild unlikely. The Mulhouse group was on loan from Madagascar, and "Lou-lou" would be added to that group.

Dr Marc Lernould of Mulhouse Zoo organised all the paperwork at their end and we arranged all the documents at the Seychelles end. The actual journey from the vetrinary station at Union Vale, Mahé to the zoo took seventeen hours. Dr Lernould sent a fax to confirm that "Lou-lou" had arrived safe and well and that she seemed none the worse for the journey.

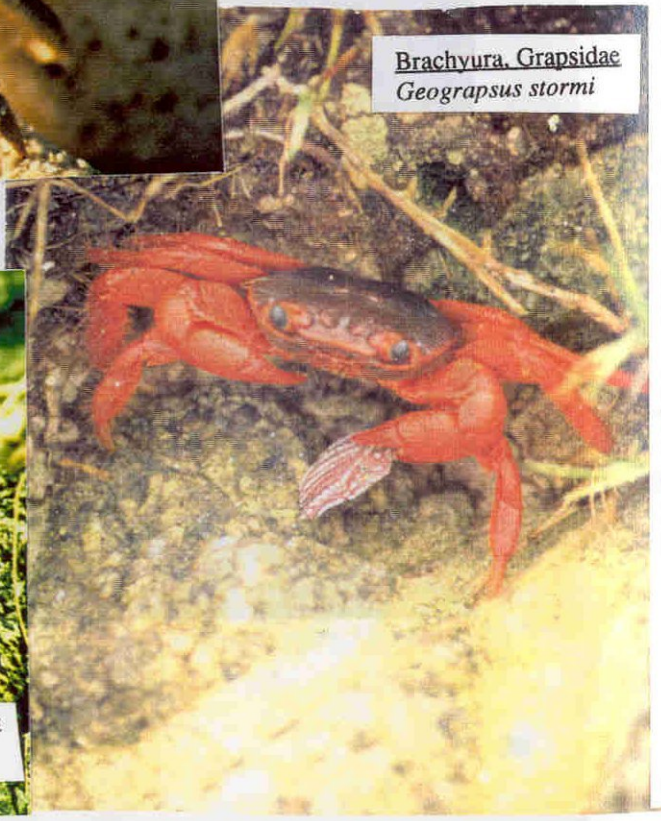
Thus ended a two year spell in a quarantine cage for this beautiful and highly endangered animal. She had been brought in illegally by a fisherman intent on using parts of her body for gris-gris (witchcraft) rituals. Fortunately word soon got around about this strange little animal and the vet Mr Bernard Moulinie visited the fisherman and confiscated the animal in September 1991. We hope her arrival in Mulhouse on 16th January 1994 will enable her to live a productive life in her adoptive breeding group.

Fig. 2. A wild blue pigeon showing the healthy wattle colour
(photo by A. Skerrett)

PLATE I

Anoumura, Coenobitiidae
Coenobita perlatus

Anoumara, Coenobitiidae
Coenobita rugosus



Brachyura, Grapsidae
Geograpsus stormi

Brachyura, Grapsidae
Geogapsus crinipes

Fig. 3. The captive blue pigeon
(photo by R. Gerlach)

Fig. 1. The female crowned lemur "Lou-lou" in the quarantine station
(photo by R. Gerlach)

Brachyura, Grapsidae
Grapsus tenuicrustatus

Brachyura, Grapsidae
Percnon planissimum

Brachyura, Ocypodidae
Ocypode ceratopthalmus

Brachyura, Ocypodidae
Ocypode cordimana

Decapod crustacean species of Aride Island, Seychelles

Carl Anderson
Department of Biological Sciences, University of Durham, U.K.*

Abstract

A survey of the decapod crustacea of Aride Island during 1993 revealed at least 28 crab species in twelve families, all of which have now been identified to at least genus level. Here I present the results of the survey which includes other information such as observed habits, known ecology and global distributions.

Introduction

Between July and November 1993, I carried out a survey of the decapod crustacea on, and around, Aride Island, Seychelles. A previous study had been carried out by Richardson (1990) who found a total of ten different crab species none of which were confidently identified. I attempted to rectify this by carrying out a more intensive study over a longer period. Searches were made of the rocky shore (both above the high water mark and in the rock pools), the beach and further inland. Searches were also made for washed up remains on the beach and records were made of incidental crab sightings. An attempt was made to photograph and take field-notes for all species. However, small specimens which were abundant were preserved in alcohol. These included crabs that were brought in with the fish from the cazier (fish-trap) moored just off the island.

The island

Aride is the most northerly of the granitic inner islands of Seychelles. The coast of the southern side of the island is dominated by an approximately 600m long stretch of fine coral-sand beach. Towards the western and eastern ends of the island are a mixture of granite and coral boulders and reef-rock. The reef rock which is mostly submerged forms water filled pools at low tide. High quality coral reef surrounds the island.

The island is one of the most important sites for breeding seabirds in the Indian Ocean. Over a million breed there each year providing much food for scavenging terrestrial crabs in the form of regurgitated fish remains, seabird chicks fallen out of their nests and older birds weakened and thus unable to fly due to the presence of sticky *Pisonia grandis* seeds in their feathers. Piles of fallen palm leaves provide protection during the day.

The island thus provides a range of habitats for terrestrial, inter-tidal and marine crabs. However, it must be noted that there are no freshwater streams on the island and no areas of mangrove. Figure 1. shows a map of the island and its different habitats in which crabs were surveyed.

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* Present address : 14 Harvesters Close, Mierscourt Road, Rainham, Kent. England

Table 1.: Decapod crustacean species list for Aride Island, Seychelles

Anomura

Coenobitiidae

1. *Coenobita rugosus* (H. Milne Edwards, 1837)
2. *Coenobita brevimanus* (Dana, 1852)
3. *Coenobita perlatus* (H. Milne Edwards, 1837)

Diogenidae

4. *Calcinus laevimanus* (Randall, 1839)

Galatheidae

5. Galtheid - *Galathea* ? sp.

Porcellanidae

6. *Petrolisthes lamarckii* (Leach, 1820).

Brachyura

Grapsidae

7. *Grapsus tenuicrustatus* (Herbst, 1783)
8. *Geograpsus stormi* (De Man, 1895)
9. *Geograpsus crinipes* (Dana, 1851)
10. *Geograpsus grayi* (H. Milne Edwards, 1853)
11. *Metopograpsus messor* (Forskål, 1775)
12. *Percnon planissimum* (Herbst, 1804)

Portunidae

13. *Thalamita picta* (Stimpson, 1858)
14. *Thalamita admete* (Herbst 1903)
15. *Charybdis (Goniosupradens) obtusifrons* (Leene, 1936)
16 *Charybdis (Charybdis) natator* (Leene, 1938)

Gecarcinidae

17. *Cardisoma carnifex* (Herbst, 1784)

Ocypodidae

18. *Ocypode ceratopthalmus* (Pallus, 1772)
19. *Ocypode cordimana* (Desmarest, 1825)

Xanthoidea

Xanthidae

20. *Zosimus aeneus* (Linnaeus, 1758)
21. *Macromedaeus nudipes* (A. Milne Edwards, 1852)
22. *Pilodius areolatus* (H. Milne Edwards 1834)
23. *Daira perlata* (Herbst, 1790)
24. *Chlorodiella laevissima* (Dana, 1852)

Carpiliidae

25. *Carpilius maculatus* (Linnaeus, 1758)

Pilumnidae

26. *Pilumnus* sp.

Menippidae

27. *Eriphia scabricula* (Dana, 1852)
28. *Eriphia sebana* (Shaw and Nodder 1803)

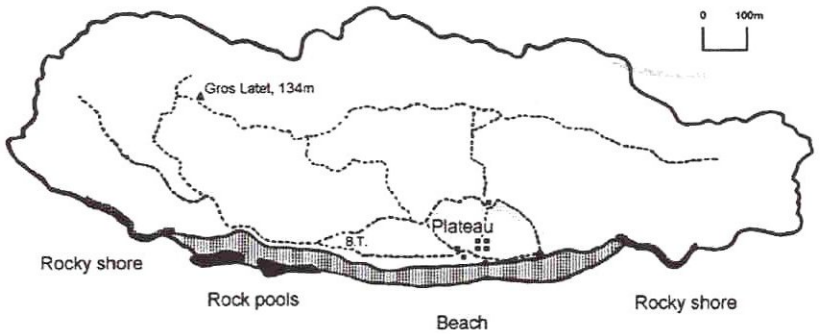


Fig. 1. Aride Island - showing habitats mentioned in the text

Results

In total 28 different species in twelve different families have been identified down to at least genus level. Table one shows the results of the survey.

One particular species, *Carpilius maculatus* was found washed up on the beach and it cannot be proven definitely that it originated from the reef immediately surrounding the island (although that is likely). The position of the fish trap is assumed to be part of the island.

Eight species are common to those found on Mahé by Taylor (1968). They are: *Ocypode ceratopthalmus, O. cordimana, Cardisoma carnifex, Thalamita admete, Percnon planissimum, Coenobita rugosus, Metopograpsus messor* and *Petrolisthes lamarckii.*

ANOMURA

The Coenobitiidae - terrestrial hermit crabs

Coenobita rugosus

Global distribution : East coast of Africa to Line Islands and Tuamotu Archipelago (Haig 1984).

These small hermit crabs occupied shells with openings up to 40mm across. They are a largely terrestrial species generally found foraging above the high tide mark. They were numerous and were particularly common along the beach crest congregating mostly in the cooler conditions amongst fallen palm leaves by day. Their bodies are whitish with some greyish tingeing over the periopods (legs). Large numbers were found in damp hollows such as those underneath the puzzle-nut tree (*Xylocarpus sp.*) in the B.T. area of the plateau. Also locally common on the beach at night. Surprisingly adept at climbing up/down granite, reef rock areas between beach and beach crest. **See Plate I.**

Coenobita brevimanus
Global distribution : East coast of Africa to Line Islands and Tuamotu Archipelago (Haig 1984).
Large and heavy dull purple individuals (shell to 80mm across opening). Very powerful chelipeds (pincers) up to 40mm long. The left-hand cheliped is usually the larger of the two. Found in the depths of fallen palm leaves during the day. Mainly nocturnal. When picked up they the habit of reaching forward and when they find that they cannot reach the ground, they rapidly extricate themselves from their shells and scurry off. Mostly occupy turban shells (*Turbo sp.)* but are known to utilise coconuts.

Coenobita perlatus
Global distribution : Aldabra and Madagascar to Line Islands and Gambier Islands (Haig 1984).
White individuals with medium to heavy orange tingeing. Shell opening to 60mm. Often seen at night although occasionally by day, almost exclusively on the beach. Appear to travel long distances over the beach scavenging for food. **See Plate I**

The Diogenidae - shallow water hermit crabs
Calcinus laevimanus
Global distribution : Widely distributed in Indo-West Pacific, from East Africa, Madagascar, Seychelles to Japan and Hawaii (Lewinsohn 1982).
Marine hermit crabs. Shell openings to 10mm. Inhabit variety of shells (including *Nerita spp.* and *Cerithium* spp., pers. obs.) often of a size that appear to dwarf the occupant. Extremely common in rock pools such as those exposed at low tide near western beach. They have a very striking colouration and are unlikely to be confused.
Eyes - rounded light blue eyes with black cornea set on eye peduncle (eye-stalk) of which the upper 2/3 is orange and the last 1/3 blue.
Antennae - two sets, inner set blue with orange joint and orange antennule flagella, outer set fine, long, orange flagellae
Shield - grey/green colouration.
Chelipeds - all individuals with larger left cheliped. - approximately 50/50 chocolate brown and white with a wavy demarcation line between the two colours. Other periopods brown.

The Galatheidae - 'squat lobsters'
Galatheid - probably *Galathea sp.*
Small species recovered from the fish-trap. Some members of this genus are known to be associated with coral. Specimen found was lobster shaped with an elongated shield compared to all of the other crab specimens found on Aride (shield length 4mm, shield width 2mm). The first periopod was also relatively elongated (7mm) with many forward pointing spines. Last pair of periopods were

vestigial. Eyes were relatively large and were flat on the forward pointing face. Between the eyes was a symmetric series of nine flat, large spines increasing in size to the central spine.

The Porcellanidae - porcellain crabs

Petrolisthes lamarckii.

Global distribution : Indian Ocean. Mainland from S. Natal to E. coast of India including Red Sea and Persian Gulf, Aldabra, Cosmoledo, Glorioso Is., Comoro, Madagascar, Amirantes, Seychelles, Coetivy, Mauritius, Chagos Archipelago, Nicobar Is. and Mergui Archipelago. Malay Peninsula and Palau Is.; Indonesia S. to Queensland; Ogasawara and Palau Is. E. to Line and Gambier Is. (Haig 1983).

Small specimen (shield width approximately 5mm) recovered from the fish-trap. It is a littoral and shallow sub-littoral species occurring under rocks and on coral. They are filter/deposit feeders. On Mahé, *Petrolisthes lamarckii* is extremely common on coral boulders (Taylor 1968). **See Plate II.**

BRACHYURA (True crabs)

The Grapsidae

Grapsus tenuicrustatus

Global distribution : Red Sea and East Africa to Japan and Hawaii (Crosnier 1965).

Extremely conspicuous and common diurnal crab. Shield width is up to 100mm which can be black and dark green to black and yellow. They are dorso-ventrally flattened and are very capable of scurrying across rocks at high speed and even leaping between them. They are very wary of humans and appear to have good eyesight - at least well able to detect movement of large objects at a distance. Only found on rocky shore areas such as that found at either end of the beach and retreat into rocky clefts when endangered or leap into sea. They are micro-algae feeders and have specially adapted chelipeds for scraping off their food from the surface of rocks in areas of wave action. Dead specimens often seen above high tide mark, usually bleached white and red by sun. Colloquially known as 'Rocher' or 'Swift-footed' crab. **See Plate I.**

Geograpsus stormi

Global distribution : East coast of Africa to Japan and Polynesia (Haig 1984)

Shield to approximately 50mm across - dorso-ventrally flattened. Appeared to be present on Aride in two distinct morphs. In the first, the shield is dark/brown to maroon with lighter brown and hairy periopods. The second which appears to be the more common (although this could be a product of their greater conspicuousness) has bright blood red/orange periopods. Both have rounded black eyes and chelipeds of equal size which appear adapted for predation. Seen on rocky shore above water mark. **See Plate I.**

Geograpsus crinipes

Global distribution : Red Sea and east coast of Africa to Hawaiian Islands and Easter Island (Haig 1984).
This is a large terrestrial carnivorous crab. It is of camel/beige colouration with equally sized predatorily adapted chelipeds. It was often seen on the path near the beach crest feeding on medium to small ghost crabs (*O. ceratopthalmus*). However, Alexander (1979) reports that on Aldabra, *Coenobita rugosus* is heavily preyed upon by this species. It is mostly crepuscular and nocturnal. Several were often seen together congregating on piles of coral on western beach. Several were also regularly seen along the beach path. Lives in burrows inland. **See Plate I.**

Geograpsus grayi
Global distribution : East coast of Africa to Japan and Society Islands (Haig 1984).
A species that in appearance is very similar to above. Individuals are an off-white with the uppermost area of the shield (width 50mm) being a dark brown/black. Only two individuals were seen on the island. The first was approximately 50m up the hill whilst the second was on the front beach path. Both incidents were at night. Little is known about its habits although this may be the species that Richardson (1990) reports as eating mice.

Metopograpsus messor
Global distribution : Red Sea, East Africa and Seychelles to Japan and Hawaii (Titgen 1982)
Found on loose rocky shores although are usually mangrove species (P. Hogarth pers. comm.). Haig (1984) classifies *M. messor* as occurring in rocky littoral fringe. Shield width is approximately 7mm, the shape of which is trapezoid. It has rounded black eyes set on peduncles at the anterior corners of the shield. Chelipeds are equally sized and a few large coarse brown hairs are to be found on the last pairs of periopods.

Percnon planissimum
Global distribution : Red Sea and East Africa to Australia, Japan and Hawaii (Crosnier 1965).
Dorso-ventrally flattened individuals. Shield to approximately 20mm across. Black/dark brown with green markings. Small round black eyes. Projections coming out of shield between eyes. Row of short spines on anterior pair of periopods. Both pincers are equally sized and appear to be adapted for algal feeding. Found in rock pools at low tide. It is an inter-tidal species usually found on rock platforms or reef flat (Crosnier 1965). It is rarely seen exposed to air but can be observed active under water to depths of several metres (Hartnoll 1992). Taylor (1968) describes it as having long legs and long pointed dactyls, being very fast moving and found on cast up boulders on the algal ridge area of the reef. **See Plate I.**

The Portunidae - swimming crabs

Thalamita picta
Global distribution : Red Sea and East Africa to Japan, Australia and Hawaii (Stephenson 1972)
An inter-tidal species that is found under dead coral (Crosnier 1962). Shield width is approximately 20mm and the shape is similar to that of *Charybdis (Goniosupradens) obtusifrons*. The last set of periopods are dorso-ventrally flattened so as to facilitate swimming. Colouration is a cryptic pattern of green and beige and the ends of the chelipeds a reddish brown. The appearance of this species varies with size and apparently with wear (Stephenson 1972). **See Plate II.**

Thalamita admete
Global distribution : Red Sea and East Africa to Australia and Hawaii (Stephenson 1972).
Small species recovered from the fish trap. Known to occur under stones (Crosnier 1962). It is inter-tidal to 13m found on mainland coast and coral reef areas, under stones and amongst mussel clamps (Stephenson 1972). It is a carnivorous swimming crab occurring on Mahé, where it is common, and seen to feed upon other xanthid crabs; they are active at rising tide (Taylor 1968). Last pair of periopods is adapted as paddles for swimming. The shape of the shield is similar to the two charybdid specimens found. However, the rostrum (part of shield between eyes) was relatively flat and devoid of spines or projections. Periopods were relatively long and slender and the 1st periopod contained some large spines particularly on carpus (second major segment of 1st periopod). There were four large projections on each side of the shield (shield width 9mm). Dactyls were relatively long, crossed over at the tips and had interlocking cutting edges.

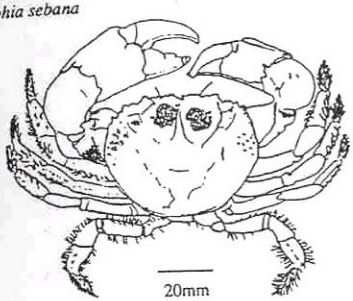
Charybdis (Goniosupradens) obtusifrons
Global distribution : Red Sea and Madagascar to Japan and Australia (Stephenson 1972).
Two shields were washed up on the beach. Both had a series of triangular projections on the anterior margin of shield. Colouration was of a lightly speckled brown overlaid with short, fine, light-brown hairs. Shield width of one specimen was 65mm. It is an inter-tidal species to a depth of 9m (Stephenson 1972) but also occurs on muddy bottoms (Crosnier 1962).

Charybdis (Charybdis) natator.
Global distribution : S.E. Africa to Japan including Australia and Lord Howe Islands (Stephenson 1972). Recorded as occurring in the Seychelles by Crosnier (1984).
Marine species trawled to 60m and found in sand, mud and weeds and also lives on coral (Stephenson 1972). Shield width approximately 20mm. Last pair of periopods adapted as paddles for swimming. Forward pointing projections are to be found on both chelipeds. There is a series of triangular projections on the anterior margin of the shield. **See Plate II.**

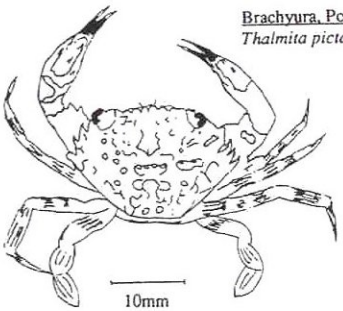
PLATE II

Some of the other decapod crustaceans to be seen on Aride

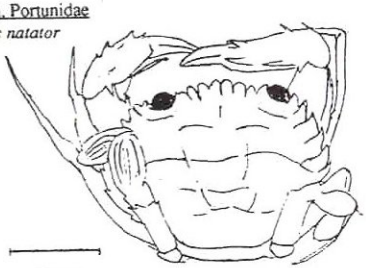
Brachyura, Xanthidae *
Eriphia sebana



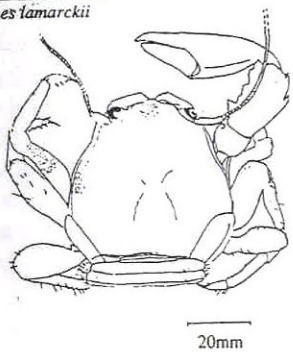
Brachyura, Portunida
Thalmita picta



Brachyura, Portunidae
Charybdis natator

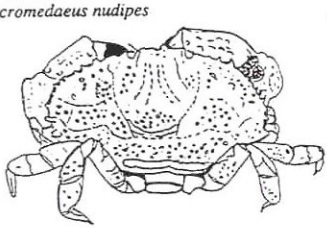


Anomura, Porcellanidae
Petrolisthes lamarckii

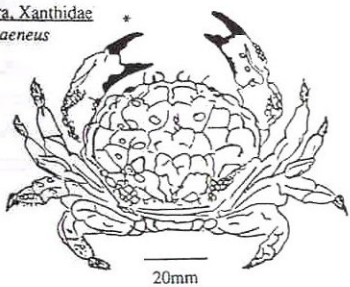


Brachyua, Xanthidae
Macromedaeus nudipes

10mm

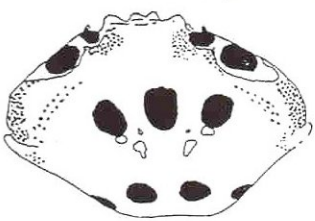


Brachyura, Xanthidae *
Zosimus aeneus



30mm

Brachyura, Xanthidae
Carpilius maculatus



* Redrawn from Garth and Alcala (1977)

The Gecarcinidae

Cardisoma carnifex

Global distribution : Red Sea and east coast of Africa to Line Islands and Tuamotu Archipelago (Haig 1984).

'Land' or 'coconut' crab. An extremely common nocturnal species. Shields to approximately 45mm across. Colouration of crab varies between mid purple and pale green/dark purple. One of the chelipeds is larger than the other. Eyes are black on short broad peduncles. Found on plateau area digging burrows into the soil. It is semi-terrestrial. Alexander (1979) states *C. carnifex* as herbivorous and detritivorous with an important role in leaf litter turnover. Common on Mahé in mangrove and supra-littoral environment (Taylor 1968).

The Ocypodidae

Ocypode ceratopthalmus - Ghost crab

Global distribution : East coast of Africa to Clipperton Island (Haig 1984).

A very common and conspicuous species of sandy beaches. Shield width (between lateral projections) is to at least 44mm. Colouration is usually of a pale green but can vary from dark green to green/purple. Chelipeds are dissimilar and those with larger left or right-hand chelipeds are present in approximately equal proportions in the population on Aride (pers. data). The most striking feature are their elongated pale orange eyestalks. They are macrophagous and active both by day and night scavenging for food along the strand line. During the *Pisonia grandis* fruiting season (October) many crabs were seen fighting over and feeding off the dead seabirds on the beach. The males build complex spiral-pyramid copulation burrows on a lunar cycle with the greatest density of burrows at new moon (pers. obs.). They get their name from the ghostly appearance of their colourless young and they way that when they half dig themselves into the sand to avoid danger, they appear to 'melt' into the surroundings. **See Plate I.**

Ocypode cordimana

Global distribution : Red Sea and east coast of Africa to Japan and Society Islands (Haig 1984).

Another species to be found in large numbers on sandy beaches. Of a similar size to *O. ceratopthalmus*, they have a more rounded shield and robust appearance. Eyes are black and rounded. Chelipeds are dissimilar. On Aride, burrows were built on the upper third of the beach where the gradient was greater. They were horizontal or sloped downwards and were usually straight but could be slightly curved (direction depending upon handedness of occupant - pers. data.). They were seen scavenging on the beach and even dragging dead seabirds down into their burrows. **See Plate I.**

XANTHOIDEA (A superfamily)

The Xanthidae

Zosimus aeneus

Global distribution : Widely distributed in Indo-West Pacific, from Red Sea and Cape to Japan, Hawaii and Australia (Serène 1984)

These are squat looking individuals with shield to 80mm across. They have small rounded eyes and chelipeds of equal size. A bilaterally symmetric reticulate pattern of grooves over the shield gives rise to 'knobbles'. Colloquially known as the 'knobbly sea-crab'. Colouration of individual is mainly white with orange markings although on shield, the knobbles show a variety of brown/orange, blue/purple and white colouration also in a roughly bilateral symmetric pattern. Live specimens were seen in rock pools but shields of dead specimens were very frequently washed up onto the shore. The crabs are covered in a mass of short hairs increasing the cryptic effect of the colouration although washed up specimens rarely show this having been worn smooth by wave action. The flesh of this species is highly toxic (Garth and Alcala 1977). **See Plate II.**

Macromedaeus nudipes

Global distribution : Widespread in Indo-West Pacific, from Seychelles, Mauritius and Madagascar to Tahiti and New Caledonia (Serène 1984).

Found in rock pools at low tide near western beach. Similar looking to *Zosimus aeneus* but shield width only 28mm and it is less hairy. **See Plate II.**

Pilodius areolatus

Global distribution : Widely distributed in Indo-West Pacific, from Red Sea, Seychelles and East Africa to Philippines, Japan and Hawaii (Clark and Galil 1993, Serène 1984).

Similar to *Zosimus aeneus* but of a medium brown colouration and smaller (shield width is approximately 20mm). It is an inter-tidal species and the chelipeds appear to be adapted for feeding on algae. Left cheliped of specimen found was approximately 50% larger than the right (i.e. 9mm and 6mm height respectively).

Daira perlata

Global distribution : Indo-West Pacific distribution, including Laccadives, Mauritius and Seychelles (Titgen 1982).

A similar looking crab to *Zosimus aeneus* but smaller (approximately 48mm across shield). The only individual found was dark brown. However, a left first periopod was washed up on the beach and was of a mauvish colouration.

Chlorodiella laevissima

Global distribution : Widely distributed in Indo-West Pacific, including Red Sea, East Africa, Mauritius and Seychelles (Titgen 1982).

Small species recovered from the fish trap. There is considerable intraspecific variation, with several more or less distinctive forms (Serène 1984). Specimen found was male with a smooth scalloped shaped shield (width 5mm). Chelipeds appeared to be adapted for algal grazing and the left one was approximately 50% larger than the right. Eyes were rounded on short peduncles. There were many short forward pointing spines and relatively long, widely spaced hairs, on periopods 2 - 5. There were three short spines on each side of the shield.

The Carpilidae

Carpilius maculatus

Global distribution : Widely distributed, including Kenya, Mauritius and Madagascar (Titgen 1982)

'Red spotted' or 'eleven spotted' crab or 'crab onze taches' A specimen was washed up on the western beach measuring 110 mm across shield. It has close set eyes and a huge right cheliped. It is a pale yellow in colouration although the dorsal area of the shield is mainly a light brown with a symmetric pattern of eleven maroon spots (or part spots). A specimen is exhibited in the National Museum in Victoria and the information reads "It is an inhabitant of open reef areas where there is a considerable surge from the outer sea. Although not abundant, it is most commonly observed crawling around rocks and corals in shallow water. It seems that very little is known about its habits. It is listed in Mauritius as toxic". Another member of this genus (*C. convexus* Forskål 1775) is described as being highly poisonous by Garth and Galil (1977). **See Plate II.**

The Pilumnidae

Pilumnus sp.

Small species recovered from the fish trap. Shows a degree of similarity to *Pilodius areolatus*.

The Menippidae

Eriphia scabricula

Global distribution : Red Sea, East Africa, Madagascar, Mauritius, Seychelles, Maldives (Serène 1984, Titgen 1982).

A similar looking crab to *Eriphia sebana* and was found in rock pools at low tide. The specimen was a female with shield width of 18mm. It has powerful crushing chelipeds, the right one of which was larger than the left (i.e. 8mm and 6mm cheliped heights respectively). The overall colouration was of a dark brown and the dorsal area of the crab was covered in short coarse hairs (unlike *E. sebana*). The 1st periopods were studded with many small protrusions.

Eriphia sebana

Global distribution : occurs in western Indian Ocean (Serène 1984).

Very stocky looking crab with shield to 100mm. Overall, it has a light brown colouration with huge identical general purpose chelipeds which are speckled a

lighter brown than that of the shield. Its most distinctive feature are its bright red bulbous eyes. It appeared to be more common towards late October/November when a few smaller individuals were seen in rocky clefts in the inter-tidal zone. The flesh of this crab is highly toxic (fatally so) to man and other animals (Garth and Alcala 1977). **See Plate II.**

Acknowledgements

I would like to thank the B.M.T.A. Education and Welfare Trust who generously sponsored my visit to the Seychelles and to all of the staff of Aride Island Nature Reserve. Many thanks also go to Paul Clark, Dr. C.H.J.M. Fransen who identified the material, Dr P. Hogarth who provided much additional information and help and to Dom. and Al. Read who helped with the fieldwork. Finally, I would like to thank the Department of Biological Sciences, University of Durham, U.K. who provided facilities for writing up.

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Patterns of species diversity among the Seychelles islands

Justin Gerlach
Department of Zoology, South Parks Road, Oxford, UK
PO Box 207, Victoria, Mahé, Seychelles

Key words: island biogeography, amphibia, mollusca

Abstract

A comparison of the relationships between species number and island area or height indicated that height is the best predictor for molluscs and amphibians. This is probably due to the relationship between island height and rainfall or habitat diversity. Other taxa (birds, plants and reptiles) give inconclusive results following from incomplete data, unidentified extinctions or ongoing colonisation.

Introduction

Patterns in the numbers of species of animals and plants occuring on islands or in habitat patches are frequently explained by the theory of island biogeography relating species number to island area (MacArthur & Wilson 1967). Several more recent studies, particularly those pertaining to plant numbers on islands in the Great Barrier Reef (Heatwole 1991) have identified other variations on this theme centering on island height - species number relationships. To date there have been few attempts to apply island biogeography theory to the islands of the western Indian Ocean. Previously published studies have included birds (Diamond 1984) terrestrial molluscs (Peake 1971) and amphibians (Nussbaum 1984). Recent advances in the thoroughness of species lists have resulted in a great increase in the volume and accuracy of data available for such applications for fauna and flora of the Seychelles island group. Data are presented below for the land mollusca, reptiles, amphibians, birds and plants and the resultant relationships discussed in terms of ecological saturation, recent extinction and the contribution made by introductions. The numbers of species of various taxa are compared to island area or height using data from Nussbaum (1984) (amphibia), Cheke (1984) (reptiles), Robertson (1989) (plants) and Gerlach (1994) (snails). Pearson's correlation tests were used to identify significant correlations between species numbers and the area or height varaiables. Both raw data and log transformed data were used.

Results

The results of these comparisons are shown in Table 1. Reptiles and plants from the corraline islands are considered in more detail in Table 2. In all tables significance levels of correlations are given as:

* = $P<0.05$
** = $P<0.01$
*** = $P<0.001$

Table1. Pearson's correlation

	all islands				grantic only			
	area	log area	height	log height	area	log area	height	log height
amphibia	0.46**	0.63***	0.97***	0.79***	0.72***	0.94***	0.96***	0.78***
log amphibia	0.35**	0.56***	0.90***	0.86***	0.57*	0.88***	0.87***	0.85***
reptiles	0.36**	0.52***	0.76***	0.85***	0.48	0.71***	0.74***	0.85***
log reptiles	0.32**	0.49**	0.64***	0.88***	0.39	0.62**	0.65**	0.89***
plants	0.76***	0.82***	0.75***	0.46	0.87***	0.88***	0.86***	0.55*
log plants	0.41	0.64**	0.40	0.38	0.45	0.68**	0.62**	0.48
snails	-	-	-	-	0.87***	0.92***	0.97***	0.69**
log snails	-	-	-	-	0.71***	0.90***	0.95***	0.85***
land snails	-	-	-	-	0.82***	0.91***	0.97***	0.68***
log land snails	-	-	-	-	0.67**	0.88***	0.90***	0.73***
native snails	-	-	-	-	0.83***	0.92***	0.97***	0.71***
log native snails	-	-	-	-	0.69***	0.89***	0.94***	0.85***
birds	-	-	-	-	0.65*	0.90***	0.77*	0.80**
log birds					0.63*	0.89***	0.77**	0.82**

Table 2.

	area	log area	height	log height
reptiles	0.389	0.445	0.466*	0.469*
log reptiles	0.341	0.396	0.448	0.423
plants	0.492*	0.548*	0.676**	0.582**
log plants	0.749***	0.791***	0.845***	0.806***

This comparison shows that for all the islands the most significant interactions are:

amphibia - height
log reptiles - log height
plants - log area

for granitic islands only:

amphibia - height
log reptiles - log height
plants - log area
snails - height (for all snails, terrestrial snails, terrestrial native snails)
birds - log area

and for coralline islands only:

reptiles - log height
log plants - log height

The variables are combined in Table 3. in order to identify cases where area and height combine as predictors of species number.

Table 3.

		Variables		First variable		Total	
		1	2	r^2	F	r^2	F
all islands	amphibia	height	log area	0.934	564.55***	0.937	289.89***
	log reptiles	log height	log area	0.453	32.28***	0.532	21.57***
	plants	log area	height	0.670	81.06***	0.766	63.89***
granitic	amphibia	height	log area	0.920	230.34***	0.951	184.40***
	log reptiles	log height	log area	0.500	20.07**	0.516	10.11**
	plants	log area	height	0.783	72.11***	0.792	36.16***
	snails	height	area	0.942	179.18***	0.968	152.62***
	birds	log area	log height	0.780	31.96***	0.800	14.006**
coralline	reptiles	log height	log area	0.220	4.80*	0.236	2.46
	log plants	log height	log area	0.339	9.24*	0.457	7.14*

Discussion

The combination of variables shows that in all cases addition of a second variable does increase the explaned variance (r^2) but reduces the significance of the regression, the second variable is thus not a helpful addition. For the amphibia the full data set provides the best regression due to the numerical dominance of the small, low islands which do not support amphibia. Reptile species number is associated with island size but the extremely low r^2 values indicate the importance of other factors in determining numbers. What these other factors might be is not clear, but may include ongoing active colonisation of the islands. Interestingly reptile diversity is very poorly correlated with island size on the corraline islands, which would be expected to be the first to be colonised by new species immigrating from souce popultaions in the Malagasy region and thus may not exhibit any clear biogeographical patterns. This possibility of ongoing colonisation affecting the regressions has also been suggested by Gardner (1986) who also cites several recent colonisation events (such as *Mabuya sechellensis* to Bird and Denis islands and *Phelsuma* spp. to several of the Amirantes in the last 100 years).

Plants correlate reasonably well with island size, area being the predominant influence. This breaks down when the coralline islands are considered in isolation; the primary influence being log height which only explains 34% of the variance. Snail diversity is almost entirely explained by island altitude.

Niche filling

According to the theory of island biogeography the curve of species number - island size for stable communities should take the form

$$S = CA^Z$$

with z = 0.27-0.35. For the groups studied above the following are obtained

	z	
log all reptiles = 0.17 log height + 0.41	0.17	
birds = 6.10 log area + 7.72	0.17	
snails = 0.06 height + 0.22		0.41
all amphibia = 0.13 log height - 0.08		0.45
all plants = 137.23 log area + 8.85	0.72	

Thus on theoretical grounds alone it would appear that the numbers of reptiles and birds observed are much lower than their theoretical stable value wheras amphibia and snails are slightly above the stable value with plants being greatly in excess. This has some support when the biogeographical properties of the different groups are considered. As suggested above the low significance of reptile regressions may be due to ongoing colonisation.

The data set analysed above gives a significant result for granitic island birds and area in contrast to the findings of Diamond (1984) for native birds, however Diamond (1984) reported a significant result for the total avifauna. The z vaule is improved in this analysis (rising from Diamond's 0.12 for natives to 0.17), they may remain below a stable value due to extinctions caused by human disturbance. To test this possiblity two further regressions were tested. For the first the minimum number of species recorded on each island was used and for the second widespread distributions were assumed giving each island several of the species that have not been recorded there historically:

	z
restricted range	0.17
generally assumed fauna	0.17
widespread	0.22

The widespread model gives the most stable value of z which may indicate that the original avifauna of Seychelles was more uniformly distirbuted between the different islands than is usually assumed. It may also indicate that we do not know of all the extinctions that occured after human colonisation. In accordance with this uncertainty a research project into subfossil deposits on the granitic islands is planned.

A similar data manipulation improves the fit of the snail data; using only species numbers for presumed native species gives z = 0.39 which is marginally less than the original value, however the original may be better as it is identical to that of the amphibia where none of the species are believed to be introduced.

The best fitting regressions and most stable numbers are produced by amphibia and snails, both of these are very strongly associated with island hieght due to high humidity requirements (high islands tending to have highest rainfall values). Both these faunal elements are largely comprised of vicariant species that must have been present since the islands were isolated from India 65 million years ago (92% of amphibians and at least 50% of molluscs), thus colonisation is only a limited component of the recent biogeographical history of these two groups. This

is not the case with the plants where the majority of the fauna is composed of species that have arrived relatively recently, many introduced by human activity, this un-natural component may be the cause of the elevated numbers of species producing a z value over twice the theoretical maximum.

Height or area ?

The most interesting associations are those between ampibians or snails and island height. The usual variable is area, height may be a more significant factor for two reasons; it is a good predictor of rainfall which is an important influence on certain taxa (eg. amphibians and snails) and is also associated with habitat diversity. There is insufficient data on rainfall from most islands to allow the significance of this component to be evaluated. Habitat diversity data are similarly scarce, a comparison of regressions using the available data on the numbers of habitat types on each island (using the classification of Gerlach 1993) indicates that habitat diversity is correlated with island height:

height:

habitat = 0.02(height) + 1.95 r^2=0.86 F=83.26 P<0.001

area:

habitat = 0.06(area) + 3.07 r^2=0.30 F=17.53 P<0.001

The area regression is also significant but explains only a third of the variance. More data from a greater range of islands are needed to refine these relationships and to investigate the details of the associations.

This evaluation of the currently available data identifies several problems that obscure the precise nature of the relationships. It would be expected that significant regressions would be obtained between plants and area for the corraline islands as has been found in most other island groups (Heatwole 1991; Williams 1982), this was not found, probably due to considerable variations in the completeness of plant lists for the different islands. The problems with the bird data have been discussed above. The problems with these two data sets indicate the need for the compilation of complete species inventories and an investigation of the limited subfossil deposits. The latter should allow more reliable estimation of the numbers of plant and animal species that were lost following human colonisation.

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On the Crocodiles of the Western Indian Ocean

J. Gerlach
Department of Zoology, South Parks Road, Oxford, UK.
PO Box 207, Victoria, Mahé, Seychelles
&
K.L. Canning
Department of Earth Sciences, Downing Street, Cambridge, UK.

Key words: Seychelles, Aldabra, crocodiles, *Crocodylus porosus*

Abstract

The subfossil remains of the crocodiles of Seychelles and Aldabra were examined and the former identifed as *Crocodylus porosus*. The Aldabran material is too fragmentary to allow definite identification.

Introduction

Reports of early exploration in Seychelles described crocodiles as one of the most abundant coastal animals in the islands (Jourdain 1609, Grossin 1742, Picault 1743, Du Barré 1762, Rochon 1769, Oger 1771, Malavois 1787, Garneray 1802, Frappaz 1819; quoted in Bradley 1936, Moine 1963). Since their extinction by 1819 (according to Decary; in Bradley 1936) they have been known only in the form of occasional bones and place names (eg. Roche Caiman). The Seychelles population has generally been reported to be the Nile crocodile (*Crocodylus niloticus*) (Bradley 1936, Honneger 1966), which survives today in Africa and Madagascar, but none of the published accounts gives a clear explanation for the basis of this identification. The fragmentary fossil remains from Aldabra have been compared to Nile and African long-snouted (*C. cataphractus*) crocodiles and found to be much closer to the Nile specimens (Arnold 1976), but no further comparisons have been reported.

Given the geographical location of Seychelles the crocodiles colonising the islands must have come from a coastal population that ventured into the open ocean at least occasionally. Nile crocodiles occur on the east African coast and, in prehistoric times, crossed the Mozambique channel to Madagascar. Despite this they are rarely reported to move from the coast into open waters. The mugger or marsh crocodile (*C. palustris*) of India is equally estuarine and coastal and only slightly more geographically removed. The Indopacific or estuarine crocodile (*C. porosus*) does not occur regularly west of Indonesia but is the only species to be truly ocean-going, being reported as crossing large stretches of open water often out

Phelsuma 2 (1993): 54-58

of sight of land. The position of Seychelles means that any of these three species could have colonised the islands. Current identifications are based on the

assumption that as Seychelles is marginally closer to Africa than to India the crocodiles must have had an African origin, and of the African species only *C. niloticus* is at all probable as a colonist.

In order to confirm the identification of the Seychelles species the three skulls in the National Museum, Victoria, Mahé and the material from Mahé and Aldabra in the British Museum (Natural History) were examined and compared to the skulls of several different species in the University Museum of Zoology, Cambridge, England. These comparisons showed that the most similar species were *C. niloticus*, *C. palustris* and *C. porosus*. Additionally *C. robustus*, the extinct Pleistocene species from Madagascar, was used for comparison (specimens in the British Museum (Natural History)).

Results

The main characters of use in distinguishing between *C. niloticus*, *C. palustris* and *C. porosus* were described by Wermuth (1953). Wermuth's key is summarised below, with additional data and the inclusion of *C. robustus* specimens from the British Museum (Natural History):

1). Usually without clear preorbital ridges on snout, if present then only as short blunt elevations in front of the eye. The pterygoids are flat. Supra-occipital ridge present.

   a). Snout pointed and elongated, at least 1.5 times as long as wide. No trace of preorbital ridges. Skull roof slightly concave in older specimens, overhanging the squamosals at the side. Premaxilla-maxilla suture on palate strongly W shaped

   C. niloticus

   b). Snout relatively short & wide, rounded, total length less than 1.5 times basal width. Preorbital ridge short & blunt, extending onto the lachrymals. Skull roof flat in older specimens, not overhanging the squamosals. Premaxilla-maxilla suture weakly W shaped to rectilinear. *C. palustris*

2). Snout with clear preorbital ridges extending beyond the lachrymals. Palato-pterygoidal suture angular. The pterygoids are deeply scooped. The supra-occipital ridge is usually absent.

   a). Preorbital ridge broad, extending onto the lachrymals, converging slightly. There is no raised rim to the internal naris and the squamosal edges are not raised.

   C. porosus

   b). Preorbital ridges broad but not converging. Back edges of squamosal raised into horn-like projections. The rim of the internal naris is raised. *C. robustus*

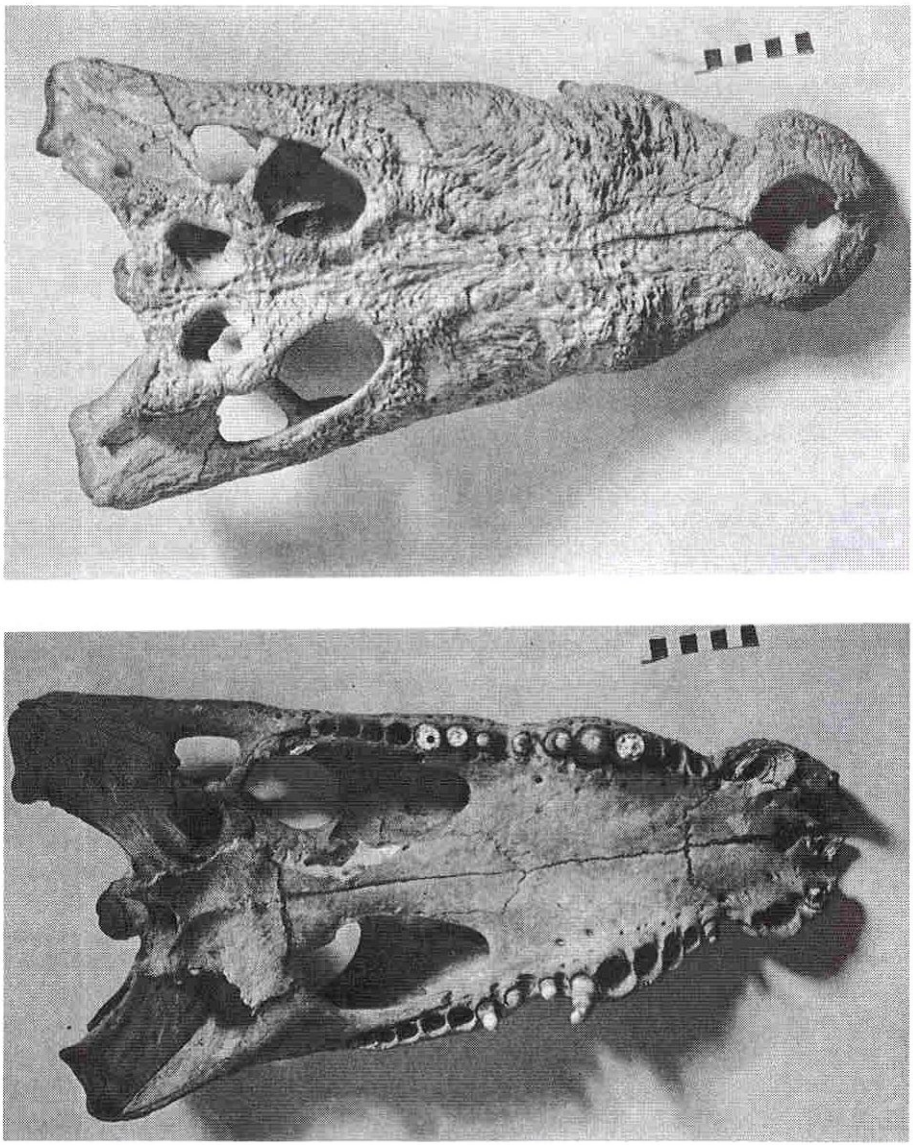

Fig. 1. Seychelles crocodile skull in dorsal and ventral views (S3)

	N	*Pal*	*Por*	*Rob*	S1	S2	S3	R8767-8885
Preorbital ridge	-	-	+	+	+	+	(+)	?
Pterygoid scooped	-	-	+	+	?	?	+	?
Parietal depressed	+	-	+	+	+	+	+	?
Supraoccipital ridge present	-	-	+	-	+	(-)	(-)	?
Palate suture angular	-	+	+	+	?	?	(+)	?
Premax-max. suture W shaped	+	(+)	-	-	?	-	-	?
Squamosal overhung	-	+	-	-	-	-	-	-
Internal naris rim raised	-	-	-	+	-	-	-	?

Discussion

There is considerable variation in the extent and size of the preorbital and supraoccipital ridges but the other characters provide a clear identification of the Mahé specimens (S1-3 & R3226-3230) as *C. porosus*. The Aldabran material (R8767-8885) is far more fragmentary (listed in Appendix 1.) with no diagnostic characters preserved in the cranial material. There is one worn scute which is closest in outline to the rectangular scutes of *C. niloticus* (*C. palustris* being oval and *C. porosus* elliptical). Thus the currently available Aldabran material cannot be satisfactorily identified.

The 1966 photograph of S3 (Honneger 1967) allows a comparison of the state of preservation of the specimens to be made. Since 1966 S3 has deteriorated in several ways, although one tooth has been replaced two teeth in the right upper jaw are now missing. Aditionally oxidised glue is now visible in several of the sutures. Examination of the specimens shows that the surfaces of the bones of all three are crumbling. The teeth are also crumbling in S3, and are especially bad in S2. This deterioration is due to fluctuations in temperature and humidity causing stresses within the bones and teeth. With the current means of storage deterioration will continue.

Acknowledgements

We are grateful to the National Museum of Seychelles and to Sandra Chapman for allowing us to examine the Seychelles specimens and the material in the British Museum (Natural History) respectively. Dr. R. E. Honneger provided his notes on the crocodiles and a copy of his 1966 photograph of specimen S3.

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Appendix 1. List of the Seychelles & Aldabra material examined

(S = Seychelles National Museum, R = British Museum (Natural History))

Specimen	Locality	Material
S1	presumed Mahé	skull
S2	presumed Mahé	skull
S3	presumed Mahé	skull
R3226	Mahé; Anse Royale	2 maxillae, teeth
R3229	Mahé; Anse Royale	2 premaxillae, lower jaw
R3230	Mahé; Anse Royale	1 premaxilla, 2 jugals, lower jaw, 4 teeth
R8767	Aldabra; Pointe Hodoul	right pterygoid
R8768	Aldabra; Pointe Hodoul	left pterygoid
R8769	Aldabra; Pointe Hodoul	right premaxilla
R8770	Aldabra; Pointe Hodoul	right premaxilla
R8771	Aldabra; Pointe Hodoul	left premaxilla
R8783	Aldabra; Pointe Hodoul	vertebra
R8784	Aldabra; Pointe Hodoul	frontal
R8785	Aldabra; Pointe Hodoul	frontal fragment
R8786	Aldabra; Pointe Hodoul	frontal fragment
R8787	Aldabra; Pointe Hodoul	left ectopterygoid
R8788	Aldabra; Pointe Hodoul	left ectopterygoid
R8789	Aldabra; Pointe Hodoul	right ectopterygoid
R8790	Aldabra; Pointe Hodoul	right squamosal
R8791	Aldabra; Pointe Hodoul	right squamosal
R8792	Aldabra; Pointe Hodoul	right squamosal
R8795	Aldabra; Pointe Hodoul	miscellaneous fragments
R8793	Aldabra; Pointe Hodoul	left squamosal
R8796	Aldabra; Pointe Hodoul	dentary fragment
R8885	Aldabra; Bassin Cabris	tooth

Notes

Some new forms of plants from Seychelles

J. Gerlach,
PO Box 207, Victoria, Mahé, SEYCHELLES
Department of Zoology, South Parks Road, Oxford, UK.

Recently several specimens of rare plants have been found, these include several forms that have not been described previously. Descriptions are given below of a new colour form of the saprophytic plant *Seychellaria thomassetii* and the male flowers of *Pisonia sechellarum*.

Pisonia sechellarum Friedmann (Fig. 1.)

The fruit and female flowers of this species have been described (Friedmann 1987). Male flowers were collected by the Oxford University Silhouette Expedition in 1990. The description below is based on a specimen preserved in alcohol in the collection of the Nature Protection Trust of Seychelles (ref. no. P/128/OUSE1). The specimen is illustrated in Fig. 2.

The flower is 6.5mm long, 8.8mm wide apically and 3.8mm wide basally. There are 5 recurved petals, the specimen described has one petal bisected, thus appearing to have 6 petals. All petals have a terminal groove. The terminal 0.5-1.2mm of each petal is hirsute. The 12 stamens extend 2.9mm above the top of the flower, being approximately 9mm long in total. Each anther is composed of two bilobed thecae, each theca measuring 0.4×1.0mm. The pedicel is 7.0mm long. In life the flowers are a pale greenish yellow and the stamens pale yellow; the preserved specimen has become a uniform dark brown.

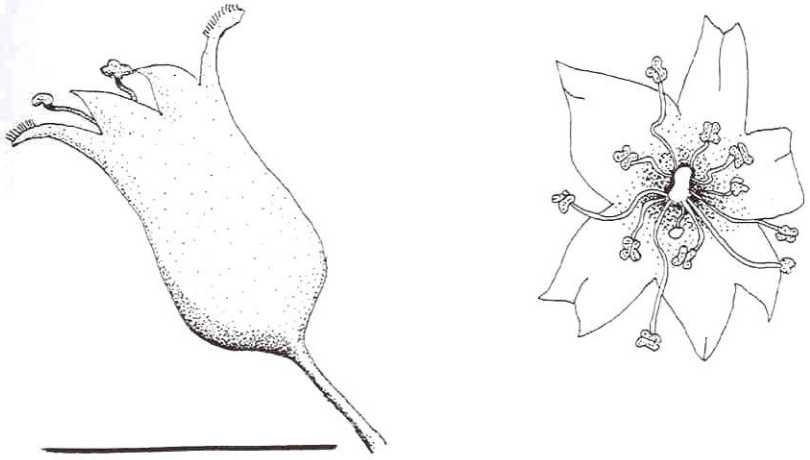

Fig. 1. *Pisonia sechellarum* male flowers - lateral & apical views, scale bar = 5mm

Seychellaria thomassetii Hemsley (Fig. 2.)

Most populations of this species are of the typical purple colour form. Two populations have been found at Coplia on Mahé that are white. These appear to be identical to the normal purple form in all features other than their colouration. They are white on the stem, flowers and fruting bodies. The root system is the typical straw colour of all other populations. The hairs on the fruit are also straw-coloured, becoming purple towards the ends (thus this is not simple albinism). In 1991 the Copolia populations include one colony of some $20m^2$ of the white form with one adjacent purple plant and an isolated single white plant.

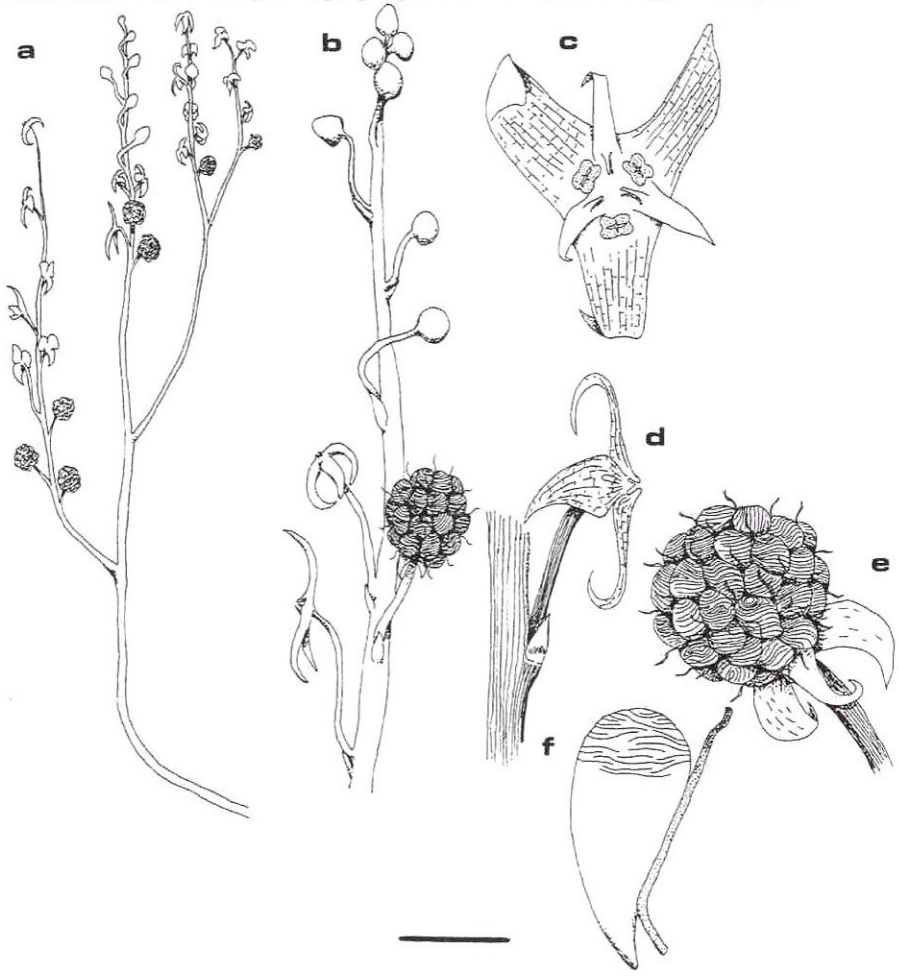

Fig. 2. *Seychellaria thomassetii* white form - a) habit; b) detail; c) & d) flower; e) fruit; f) single segment of fruit

scale bar: a) 10mm; b) 3mm; c) & d) 0.6mm; e) 2mm; f) 0.5mm

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INTRODUCTIONS OR NATURAL COLONISTS ?
Historical confusion in the case of *Foudia madagascariensis* and *Astrilda astrild*

G. & R. Gerlach,
PO Box 207, Victoria, Mahé, SEYCHELLES

Of the 19 breeding land bird species of the granitic Seychelles islands 6 are generally assumed to be introduced. The dates of the introductions of the barn owl (*Tyto alba*) and the Indian house crow (*Corvus splendens*) are known (1951 and 1977 respectively). Other introductions are undocumented - With a lack of thorough surveys prior to the first documented records of the other four species, the dates of assumed introductions are uncertain. In two cases it is possible that the colonisations of the islands may have been natural.

The Madagascar fody (*Foudia madagascariensis*) was assumed to have been introduced in 1879. The date attributed by J.H. Crook to A.A. Fauvel and based on a personal comment by P. Lousteau-Lalanne. This rererence, in turn, is based an a comment made to R.E. Moreau in 1957 by the then Director of Agriculture, A. Jefferies. When questioned recently about this statement, Jefferies was unable to substantiate it (personal comment J. Gerlach). In any case Newton had recorded *Foudia madagascariensis* on Mahé in 1866 - 13 years prior to this supposed introduction. This record therefore invalidates Fauvel's date.

The earliest possible reference to a bird similar to the Madagascar fody was described by the Marion Dufresne expedition in 1768, two years prior to the first settlement of St. Anne. Dufresne says "J'ai aussi trouvé un oiseau qui à le plumage du corps et les ailes comme le linot, couleur brun et café, la tête et la gorge rouge cramoisi, le bec et les pattes noires." (A bird with the body and wing plumage brown and coffee-coloured like a linnet, the head and breast crimson, beak and legs black). This was on 19th September 1768 when the male *Foudia madagascariensis* would be expected to be moulting into breeding plumage.

The presence of a red-headed fody-like bird in the islands prior to human settlement raises the possibility that *Foudia madagascarienis* may have been a natural colonist. If this first record were close to the date of the colonisation and only 250 years ago, no significant morphological difference between the Seychelles population and the parent stock would be detectable. The alteration of the environment by man clearing land for habitation and agriculture would have directly benefitted the fody with its preference for lower coastal areas of semi-open terrain. With the widespread distribution of this speceis throughout the western Indian Ocean, it would be difficult to separate the different populations genetically. Adaptive radiation may be prevented by periodic colonisations from the parental population undermining the process.

The second bird for which early records seem to contradict the generally held

assumption of its being an introduced species, is the common waxbill (*Astrilda astrild*). The apparently weak flight and the lack of genetic drift is thought to support the case for introduction, but this species occurs naturally throughout sub-Saharan Africa, as well as on oceanic islands like St. Helena. Small populations have been recorded in Madagascar where Langrand (1990) presumed them to be introduced. They also occur in Réunion and Mauritius where they are known by the same Creole name (Bengali) as in Seychelles.

In the very early years after St. Anne was settled and the "Etablissement" was begun on Mahé itself, the settlers began to grow crops for themselves and to provision passing ships. It is not clear what crops are referred to, but presumably some form of seed crop like millet, was planted. In 1789 the settlers had been in place for a mere 19 years when Malavois, on returning to Mauritius, reported to General Decaen that during his period in Seychelles "ces memes îles sont trés peuples d'oiseaux de terre et de mer; parmi ceux de terre, les perroquets et les bengalis font beaucoup de tort aux recoltes", (the parrots and bengalis (waxbills) did great damage to the crops) (Fauvel 1909).

There are two possibilities for the explanation of this record. Firstly, that waxbills were so numerous that they could cause "great damage to the crops" because there was already a substantial population ready to take advantage of the changing environment. Secondly (as assumed by Lionnet (1980)) that the translation of "bengali" should read "finch" and this in turn could mean fody. The presence of a substantial population of fodies would however have continued; such large flocks would have been recorded by Newton in 1867. The most likely case therefore is that the comman waxbill was already established on Mahé prior to the settlement by man.

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Seychelles sunbirds (*Nectarinia dussumieri*) on Aride Island

Carl Anderson
Department of Biological Sciences, University of Durham, U.K.*

Abstract

A census of the Seychelles sunbirds *(Nectarinia dussumieri)* on Aride Island during 1993 puts the island population at 10 - 12 birds including four females. Data collected from one nestling showed that there was a significant inverse relationship (n=11, F=8.59, p<0.02) between the number of parental visits in the morning and the evening, and between the number of visits in the morning and the date (n=14, F=8.56, p<0.02). The male carried out only 3.6 % (n=277) of the visits to the chick. Unusually in sunbirds, a group of four birds (including both sexes) were seen singing and interacting together without feeding or aggression.

Introduction

Seychelles sunbirds *Nectarinia dussumieri* (Hartlaub) have been noted on Aride Island since 1878 (Oustelet 1878) although they were probably present before this date but unrecorded. Up until 1992 all sightings were fairly casual with only a few individuals present for up to two months. It was only in 1992 that it was first confirmed that sunbirds were breeding on the island. No data has been collected on nesting behaviour of Seychelles sunbirds on Aride.

A census of the sunbirds on the island (concentrating on the plateau area) was carried out between mid July and mid September 1993.

Methods

The data was collected in July and August 1993 when nest was located in a *Pisonia grandis* tree approximately 4-5m above the ground in a conspicuous position. It was apparent that a single chick was already present in the nest. I carried out watches of the nest between 09:00 - 10:00 and 17:00 - 18:00 daily until fledging of the chick. (These times were chosen arbitrarily). I watched the nest entrance through binoculars from a semi-concealed position approximately 5m away from the nest's projection on the ground. Data were collected on the time of arrival of an adult bird attending the chick, its length of stay, duration of any incubation, sex of the adult, occurrences of faecal pellet removal and any other interesting observations. Climate data were collected daily.

The chick probably fledged on the morning of the 10th of August. (It was present at 18:00 on the 9th and had gone by 09:30 on the 10th). Thus, if we take the 10th as day 0, my data cover from day 0 to day -16.

The census was carried out using direct observations. One female on the island was already ringed. In August mist nets were put up for Seychelles brush

* Present address : 14 Harvesters Close, Mierscourt Road, Rainham, Kent. England.

warblers (*Acrocephalus seychellensis* Oustalet) but three sunbirds were also caught and ringed. This put the total at four ringed sunbirds (two males, two females).

Results

Table one shows the principal data collected.

Number of visits

There is a significant inverse relationship between the number of visits in the morning and evening ($n=11$, $F=8.59$, $p<0.02$). Consequently, the total number of visits for the two hours each day remains fairly constant (mean=19.64, S.E. mean=0.544)

There is a significant inverse relationship between the number of visits in the evening and the date ($n=14$, $F=8.56$, $p<0.02$).

Male versus female attendance

Out of the total of 277 visits observed, only 10 (3.6%) were by the male and these only occurred from day -7 onwards. Thus, the female is conducting a significant proportion of the parental care.

Faecal pellet removal

Pellet removal varied between zero and two pellets per hour over the study period. There was no significant difference between number in morning and evening.

Incubation

Length of incubation varied enormously ranging from 27seconds to 3 minutes 25 seconds. No incubation was seen after the 29th, i.e. day -12.

Climate

Although there were significant relationships between the various climate variables, there were no significant relationships between number of visits or faecal pellet removals and the climate variables.

Table 1. : number of visits in the morning and evening and pellets removed

Date	No. visits in morning		No. visits in evening	No. Pellets removed morning	evening
25/7	22		-	1	-
26/7	-		10	-	2
27/7	17		-	2	-
28/7	12		9	1	1
29/7	14		9	0	0
30/7	9		10	0	1
31/7	14		5	2	1
1/8	8		9	0	1
2/8	11		9	1	2
3/8	13	(2)*	6	2	2
4/8	16	(2)	6	1	1
5/8	14	(4)	4	1	1
6/8	14		6	2	1
7/8	10	(2)	8	1	1
8/8	-		7	-	0
9/8	-		5	-	0
10/8	chick fledged				

* Parentheses indicate visits by male

Discussion

The limited amount of data does show some significant relationships. However, it must be remembered that this can only relate to the one pair of birds studied at that time. Nevertheless, it does indicate some possible relationships which might be confirmed with a larger sample size.

The data shows an inverse relationship between the number of visits in the morning and evening. This could suggest that a short-fall in food for the chick in the morning is compensated by a greater number of visits in the evening. The small variation in total number of visits each day is supportive of this. However, this can only be answered by looking at the calorific value of all the food items. The number of visits per hour conforms to those observed by Greig-Smith (1980) although with a slightly larger range. The prevalence of female parental care is also confirmed.

On the ten occasions when the male was present (see Table 1.) the female displayed by holding out and shivering her wings, keeping her head and body held low and running up and down the perch before she flew off (or chased off?) with the male in pursuit. The male was seen to feed the chick on five of the ten occasions and in one of these, he removed a faecal pellet. Therefore, the male does show some parental care although extremely limited in comparison to the female.

The female was seen and heard to sing on twenty occasions. This has also been seen by Greig-Smith (1980) and thus disproves Penny's (1974) statement that only males sing.

Sunbirds are normally monogamous, territorial and not usually gregarious. However, they are known to feed together when food (usually nectar) is in excess. I observed a group (comprised of both sexes) of four birds in an Indian Almond tree (Badamier, *Terminalia catappa)* who were singing and interacting but not feeding or fighting. Greig-Smith (1980) notes that "..up to four males often gathered in shrubs without aggression, singing loudly and continuously for several minutes. These assemblies were always near an active nest, but their function is not clear." Thus my observations confirm this phenomenon not seen in other sunbird species, but more than that it shows that this is not just a male phenomenon.

The census resulted at a population estimate of 10-12 birds. One bird was seen approximately 50m up the 'Gros Latet' path on the hill and so the possibility remains that there are more birds higher up on the island. It is estimated that there are four pairs of birds on the plateau. One pair definitely fledged a chick. (The main subject of this report). Another may have reared a chick - reports are unconfirmed. The third pair attempted to nest and were unsuccessful. It was suspected that the fourth pair had a nest somewhere near the nest site from the previous year. However, no nest was ever found. The female from this last pair was the original ringed bird who bred in 1992.

Acknowledgements

I would like to thank the B.M.T.A. Education and Welfare Trust who sponsored my visit to the Seychelles and to the committee and resident staff of Aride Island Nature Reserve. My thanks also go to the Department of Biological Sciences, University of Durham, U.K. for providing facilities for writing up.

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